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No. 7.—VACCINATION AGAINST BOVINE CONTAGIOUS ABORTION AND THE RELATION OF THIS DISEASE TO UNDULANT FEVER IN MAN*

W. H. ANDREWS, D.Sc., M.R.C.V.S.

DIRECTOR OF VETERINARY LABORATORY, MINISTRY OF AGRICULTURE AND FISHERIES, NEW HAW, WEYBRIDGE

I propose to make no attempt to review the whole field of published work on this subject. The literature of contagious abortion is already very large, and as the subject continues to attract increasing attention in all civilised countries, it grows more difficult each year to keep in touch with all that is written, and to form a clear idea of the exact state of our knowledge of particular points. There is certainly a real, and even urgent, need for the publication of a comprehensive and sufficiently detailed review of our present knowledge, and the Imperial Bureau of Animal Health, in addition to compiling as complete a bibliography as possible, intends shortly to publish a critical review of the abortion literature which has appeared during the last five or six years.

Having regard to the limitations of the time and space at our disposal, however, I think it best on this occasion to give the general position as I see it, and to put forward my own interpretations and opinions, without referring specifically or in detail to the many pieces of evidence on which the opinions are based.

THE RELATION OF *BRUCELLA ABORTUS* INFECTION TO UNDULANT FEVER OF MAN

I think it desirable to give first place in our discussion to this portion of the chosen subject, as the existence of any menace to (human) public health must necessarily influence our whole conception of the problem, and may in part determine the practicability or desirability of particular methods of control.

It is not possible here to trace the growth of our knowledge concerning the relation between undulant fever and contagious abortion, but the story is both interesting and instructive. Some twenty-five years ago we appeared to have a satisfactory knowledge of both diseases, but no particular relation between them was suspected. Undulant fever (then commonly called Malta or Mediterranean fever) was a disease of man which was induced by infection with *Micrococcus melitensis*, and the micrococci were derived from goats, usually as a result of ingestion of infected milk. The goats did not suffer from any obvious disease, although abortion was rather prevalent among them. On the other hand, contagious abortion was essentially a bovine condition due to infection with the *Bacillus abortus* of Bang, an organism with rather peculiar and distinctive requirements for artificial cultivation. Cattle derived the infection from other cattle, mainly through the ingestion of contaminated food materials. One feature common to the two pictures was the fact that cattle infected with *B. abortus*, like goats infected with *M. melitensis*, did not usually suffer clinically from disease; various complications might occur, but as a rule they merely aborted. This feature at first drew no attention, however, because the other features seemed to differ so greatly. Undulant fever was essentially a human disease and goat infection of the Mediterranean region; bovine contagious abortion occurred widely in Britain and other cool-temperate countries in which human undulant fever had never been known to arise: the causal organisms appeared to differ clearly in morphology and cultural characters, and even more clearly in their pathogenicity for man.

It is hardly necessary to say that the original descriptions of the two organisms were in no way lacking in accuracy, and the pioneer work of Bruce in the one instance, and of Bang and Stribolt in the other, must always command our undiminished admiration. The mass of subsequent work has shown, however, that the gap between *M. melitensis* and *B. abortus*, once apparently so wide, is extremely narrow.

We now recognise the existence of a number of strains of organisms with close affinities. It is customary to class them all under the generic name "Brucella," and in relation to a few special characters, to group strains in a small number of species, including particularly *Brucella melitensis* and *Br. abortus*. The affinities are very close, however, and in some instances the most detailed study is required before a strain can be assigned to one of these species.

It should also be mentioned particularly that

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in more recent years American workers have shown that there is a porcine variety of *Br. abortus* with some special characters.

The earlier records of human cases of *Br. abortus* infection came particularly from the United States, and one may note here the pioneer contribution from Bevan in Southern Rhodesia. In these earlier cases one could justifiably entertain considerable doubt as to the identity of the infecting organism. It seemed by no means unlikely that it might be *Br. melitensis*, perhaps modified as a result of passage through bovines; alternatively, the organism might well be another variety or strain of *Br. abortus*, indistinguishable by ordinary tests but differing widely in its pathogenicity from the very common European strains. Any such views had very soon to be dropped or modified, as increasing numbers of human cases were recorded in European countries in which there is no reason whatever to suspect the existence of *melitensis* infection. Human cases of undulant fever, attributed to infection from a bovine source, have now been recorded from practically every country in Europe; in some, and particularly in Denmark, the number of recognised cases is now quite considerable, but the figures are naturally affected by the amount of particular attention that has been paid to the condition.

In 1929 Dalrymple-Champneys, in a Ministry of Health report, discussed 14 cases of human infection supposed to have been contracted in this country. Since that date the number of recorded cases has increased considerably, but I have no doubt that Dr. G. S. Wilson, who has kindly consented to open the discussion, will be able to furnish recent and authoritative figures.

The diagnosis of these human cases has not always been very convincing. In the majority of instances diagnosis is based on the presence in the blood of agglutinins for *Br. abortus*, and their presence may certainly be regarded as establishing the fact that the patient has been exposed to infection. It does not prove, however, that the patient is suffering, or has ever suffered, from actual illness as a result of the infection. Investigations have shown that sera with a fairly high agglutinating titre may be obtained from men who appear to be enjoying excellent health, and in many of these cases there is no evidence that these men have at any time suffered from an illness that could be assumed to have been undulant fever. The presence of agglutinins in apparently healthy subjects is noted particularly in men engaged in certain occupations (including veterinary surgery) which bring them frequently into contact with infected cattle.

Whatever doubts one may have concerning the diagnosis of many cases, however, there are others in connection with which one can have no reasonable doubts at all. In a number of such cases the serum-agglutination results have been fully supported by the history and clinical features, and in some (a small minority but none the less significant) *Br. abortus* has been recovered in blood-culture.

It appears now to be definitely established that *Br. abortus* of bovine origin may cause in man a form of undulant fever that is commonly benign, although sometimes rather protracted, but may be very severe and even fatal, although death is very exceptional. It has also been definitely established that *Br. abortus* may cause abortion in women, but it appears at present to be uncertain, and perhaps very doubtful, whether abortion from this cause is at all common. The *number* of well-established human infections hitherto recorded in this and most other European countries, is not at all impressive, when consideration is given to the very wide distribution of the bovine infection and its relatively heavy incidence. It can readily be understood that the disease escaped diagnosis when undulant fever was regarded as an exotic disease, and there was no obvious reason to apply special tests for its recognition. I believe that clinically the disease may assume many different aspects, and it seems most probable that a proportion of cases may still be escaping exact diagnosis. On the other hand, the subject has recently attracted a great deal of attention in medical literature, and it seems unlikely that cases of any severity will in future pass unrecognised.

Should the attention now focussed on the subject lead even to a considerable increase in the number of cases recorded, however, the number would still appear extremely small when the opportunities for infection were considered; we should see a very different picture if we had to contend with an equally widespread infection of animals with *melitensis*!

The comparatively very small number of human cases might be due to the relative insusceptibility of man to *Br. abortus*, infection or illness appearing only in occasional individuals who lacked the resistance of their fellows. On the other hand, some of the recorded facts might find an explanation in the occurrence of certain strains of *Br. abortus* with exceptional pathogenicity for man. It appears likely that both explanations are to some extent correct. In connection with the question of strains, it is important to note that undulant fever appears definitely to occur more commonly in the United States than in this country, and that American workers have found *abortus* strains of porcine origin (or type) to be more pathogenic for man. As far as we are aware, contagious abortion of pigs has never been proved to exist in Britain. We are anxious to investigate all outbreaks of abortion in pigs, but it appears that no such

outbreaks have ever been reported to us, and I would appeal to those who may encounter cases in practice to help us with information and material.

A question of obvious importance is the channel through which man acquires infection. The facts connected with the closely-allied *melitensis* infection might lead one to suspect that the ingestion of bacilli in milk is probably the commonest source of infection with *abortus*, but this idea is not supported by the peculiar incidence of the disease. In the first place it should be noted that of the human cases recorded up to the present time, a large proportion has occurred in rural districts and in adult males, and particularly in men brought by their occupations into close or frequent contact with infected cows. In Denmark, where the disease has been particularly well studied, it appears that in rural districts the incidence is six or seven times as heavy in men as in women, and Kristensen points out that it occurs there mainly as an occupational disease. In towns the sex-distribution is more equal, but even there the incidence is twice as great in the male. Cases in children are comparatively very rare, but they occur and may be severe. The evidence suggests that the adult is less resistant than the child, and that the male is much more susceptible than the female to infection through any channel. Ingestion of infected milk appears to account at the most for only a small proportion of cases in men, but it is probably of much greater importance in connection with the much smaller number of cases in women and children. It has been estimated that probably 40 per cent. of human cases may be attributed to milk infection, but it is doubtful whether we are yet in a position to frame such estimates with any confidence, and the figure may well be considerably lower. Many possibilities are yet unexplored, and in particular we may have much to learn concerning *abortus* infection in animals other than cattle.

In connection with this subject it would appear that our greatest need at present is for extended research and more definite information. It would be wrong, even if it were possible, to deny or ignore the risk of human infection, but it would probably do much more harm to exaggerate it. The evidence available at present suggests that the danger is relatively small, and much smaller than some of the risks that we incur almost daily from other sources, but it definitely exists and deserves further investigation and impartial consideration.

VACCINATION AGAINST CONTAGIOUS ABORTION

It is almost impossible to discuss the value of different methods of vaccination, and the desirability of employing them, without giving some consideration to the alternative methods that are available for the control of the disease. A brief preliminary discussion of these alternative methods should clear the ground and allow us to approach the question of vaccination with an appreciation of the general position that we have to face.

The ideal procedure is undoubtedly to eradicate the infection entirely from a herd. Where the conditions are at all suitable, this measure should always be recommended, for it is perfectly feasible, and eradication may be expected to confer considerable benefits on the owner. It is also beneficial to the community.

The possibility of eradication depends in the first instance on our ability to distinguish infected animals and separate them from the rest of the herd, and our methods of diagnosis are of fundamental importance. The serum-agglutination method, sometimes combined with complement-fixation, is practically always employed; it has been adversely criticised, and undoubtedly fails at times to pick out a small proportion of the infected animals, but it has proved to be sufficiently accurate to enable herds to be entirely freed from infection. It is of some importance to remember that the agglutination titre of an animal's serum may be low at the time the act of abortion occurs, although it usually rises within a couple of weeks. The main point in connection with the test is that it must be applied repeatedly, and that the intervals between the tests should not be too long; the intervals must be short (*e.g.*, two or three months), particularly in the earlier stages of the eradication process.

The disposal of reactors is a question of great importance, and slaughter is both impracticable and unnecessary. In some instances it may be possible for an owner engaged in building up a clean herd to dispose of all his reactors to others who possess infected herds and who are fully acquainted with the facts. This arrangement may be very useful in individual cases, but it clearly offers no help towards a general solution of the problem.

The only satisfactory policy for general adoption is the application of the "two-herd" method. In its complete form this method requires facilities for rigid separation into two herds, an infected herd that should gradually shrink and finally disappear, and a clean herd that should grow and ultimately replace the other entirely. The clean herd should normally show a satisfactory rate of natural increase, but in many instances it is likely at first to be of small size. Animals may, of course, be purchased from other abortion-free herds, but that method of herd-building will probably prove rather expensive, and in general the clean herd must be recruited mainly from the offspring of the cows in the infected herd. The heifer

calves of the infected herd are separated from their mothers as soon as practicable and protected from further infection. Experience shows that, at least in the great majority of instances, they should lose all trace of infection (and reaction) before reaching sexual maturity. At that time, subject to satisfactory tests, they may be added to the clean herd.

For complete isolation of the herds the owner must provide separate stables, utensils, implements and attendants, and the clean herd must also have separate pasture, to which infected animals have no access and over which no such animals have recently grazed. It is clearly our duty to do everything within our power to favour the eradication of contagious abortion, and to recommend these measures in every case in which there is a reasonable chance of their successful application. There are undoubtedly many owners who could provide or arrange these facilities, and they would ultimately benefit greatly from doing so. Unfortunately there are many more owners who *could not* carry out this two-herd policy. In many instances the farms are too small to allow of economical working in two units, and in very many cases the farmer could not face the capital cost of duplicating the buildings, nor the increased labour and other costs. Moreover, the plan is obviously and specifically designed to meet the requirements of the self-contained herd, and we cannot ignore the importance, in this country, of the numerous herds that undergo constant changes in composition. The eradication policy would ultimately pay every owner, but the circumstances of the present, the necessity of fulfilling milk-contracts and inability to meet the initial costs, will not permit a large number of owners to undertake it.

The impracticability of the universal application of the complete two-herd policy has been widely recognised, even in countries which are probably more suited to its application than Great Britain. Various modifications have therefore been introduced, and we have to consider a policy that does not promise complete eradication, but aims at reducing the incidence of the disease, with eradication as the ultimate goal. This general policy includes a limited measure of isolation—the greatest measure allowed by the owner's premises and means. For example, infected and non-infected cows may be housed in the same building but separated as far as practicable, and particular care has to be taken in milking, feeding and cleaning, always to deal first with the clean section. The policy also includes all those precautions which are usually referred to as "sanitary measures." The most important of these measures appears to be the isolation of the infected cow at the time of abortion or normal parturition, and for some weeks afterwards, and the careful disinfection and disposal of the aborted fœtus and of infective membranes and discharges. It seems probable that further experience and increasing knowledge will enable us to improve our methods, and a modified isolation policy may eventually prove of the greatest practical value. Those who have the opportunities and facilities may render valuable services by recommending such a policy in suitable cases, and by closely superintending the procedure and estimating the results as accurately as possible. At present it appears to be very doubtful whether such measures can be successfully applied to many of our commercial dairy herds, and in general it may be doubted whether the system would operate sufficiently rapidly and decisively to meet the needs of a herd in which infection is already widespread and abortions are occurring in considerable numbers.

It is highly desirable in every case to apply the ordinary sanitary measures, including particularly the destruction of infective materials and discharges, and the isolation of animals during the few weeks of special infectivity. In a large proportion of herds, however, these measures alone will almost certainly fail to check the progress of the infection, and in most of the herds no effective separation, other than the temporary isolation of individual cows, can at present be undertaken. We are, therefore, forced to seek other means of controlling the infection or reducing the losses caused by its presence.

Medicinal treatment appears at present to offer little, if any, help. Suitable chemical agents may be used to kill the organisms in infective materials discharged from the animal body, and they may be injected into the uterus and genital passages in order to destroy bacilli in accessible situations. There is no reliable evidence, however, that any chemical agent has a specific action on *Br. abortus*, and can therefore be employed to attack the organisms in such an inaccessible situation as the mammary gland tissue, or even in the deeper layers of the uterine mucous membrane.

Immunization against the infection by the use of killed cultures of *Br. abortus*, or of some product or extract of the organisms, has from the first attracted a great deal of attention. If really effective, such "dead" vaccines would certainly offer a practical and economical solution of a very serious problem. In earlier years the majority of the recorded experiments concerned the use of heat-killed cultures, but more recently investigators have employed such agents as chloroform, toluol and formalin. There is little doubt that the inoculation of these vaccines actually increases the resistance of animals to infection, but in comparative tests the protection conferred by them has always

been greatly inferior to that following the use of living cultures. On the available evidence it is extremely doubtful whether any of the methods practised at the present time ever confers a very significant degree of added resistance, such as may be expected to carry a seriously threatened animal safely through a pregnancy. Apart from the question of its actual strength, it appears that the partial immunity conferred by dead vaccines is usually of quite short duration. In present circumstances there may be some justification for *trying* a dead vaccine, where pregnant animals are known to be seriously threatened, and particularly if the owner is anxious for some action to be attempted. Such a situation may also provide an opportunity for testing a new type of vaccine or a new method of application. At the present time no great confidence should be placed in such vaccines, however, and the prognosis should be very guarded.

Immunization with killed organisms or extracts would, if effective, be the most desirable of methods to employ, after eradication, and it would certainly be the most practical. In spite of the disappointing results of the past, and the present absence of any real promise of success, it appears highly desirable that the possibilities in this direction should be subjected to further intensive study on an adequate scale. While one may hope that research will yet lead to the preparation of a "dead" vaccine of greatly increased potency, however, it seems at present to be improbable that any such vaccine will confer a strong and durable resistance to *Br. abortus* infection with only one inoculation, and we may well have to adopt rather complicated procedures.

THE USE OF LIVING CULTURES OF *BRUCELLA ABORTUS*

This portion of the subject is one of the greatest interest and importance, and one associated with a great deal of controversy. This form of vaccination is probably conducted on a wider scale at present than any other method of control, or attempted control, but there are many who consider that it should not be practised at all. It is used extensively in several of the leading and most highly organised stock-raising countries of the world, but in some other enlightened countries its employment is discouraged or even definitely forbidden.

The organisms are cultivated under the most favourable artificial conditions, and there is usually no attempt to attenuate or modify them in any way. In the past there has generally been no deliberate choice of any particular type of strain, and it may be assumed that the strains actually used have as a rule been virulent, although they have doubtless varied considerably in that respect. In recent years Huddleson has advocated the use of an avirulent strain of *abortus*, and Cotton and Buck have carried out experiments with a similar strain, but strains known to be avirulent have never been used on an extensive scale in practice, and there is some reason to doubt their efficacy. The vaccine is usually administered subcutaneously in relatively large amount. It might be claimed that the inoculation is equivalent to an attempt to transmit the disease, but the essence of the method is the choice of a favourable time, and animals should never be inoculated when pregnant. Pregnant animals have been inoculated experimentally at laboratories, and they have sometimes been inoculated in practice as a result of some mistake. In many instances no ill-effects have been observed, but such a procedure can never be recommended. In this country the Ministry of Agriculture has always emphasised the importance of employing the vaccine only for non-pregnant animals, and of delaying service of these animals for a period of two months from the date of inoculation.

In the bovine body *Br. abortus* appears to flourish only in a few special situations. In the pregnant uterus it multiplies very freely; it is for this reason that really enormous numbers of the organisms may be discharged during, and for a short time after, the act of abortion or parturition, and that the animal is highly infective at this period. After parturition or abortion the organisms no longer multiply freely, although they may persist for some time in small numbers; in the uterus of the virgin heifer *Br. abortus* will usually not settle and multiply at all.

The active mammary gland is also a favourable site, although *abortus* does not multiply very freely there, and it is not found in the milk in the large numbers often seen in *melitensis* infection of goats. Udder infection may persist for years, but it may be of quite short duration.

Br. abortus may persist, at least for a time, in some other situations in the body, but really suitable conditions for its multiplication seem to occur only in the pregnant uterus and, in smaller degree, in the udder.

When a non-pregnant animal is inoculated subcutaneously with living *abortus*, the only really vulnerable organ, at the time, is the udder, and in the virgin heifer even this is infected only with difficulty. In the great majority of cases, inoculated heifers have overcome and eliminated the infection before the end of the two months' period allowed before service. This is also the usual result in inoculated cows, but in them the invasion of the udder, with possible persistence of infection there, is more likely to occur. The frequency with which udder infection is set up by vaccination has not been accurately determined: it probably varies, and

from the work of the American Bureau of Animal Industry it seems to be related to the virulence of the strain of organisms employed. A limited number of observations at Weybridge suggests that with the vaccine of the Ministry of Agriculture the proportion is very small.

The use of living cultures for vaccination can never be regarded as an ideal method of combating any disease, although methods of this kind have rendered valuable services, and in some instances we could not dispense with them. When the organisms are not definitely modified or attenuated in any way, the general objection to the method is considerably strengthened. On the other hand, we are forced to give due weight to the needs of agriculture and economic facts. Contagious abortion is responsible for very serious loss, and there is every justification for the use of the living vaccine, if effective, unless a safer and almost equally effective method is available, and unless there is clear evidence that its use is in some way definitely harmful.

In connection with a large proportion of the herds of this country, it appears at present to be impossible to apply the ideal method of eradication by isolation. It also seems certain that at present we cannot expect effective help from any medicinal treatment, nor from the use of any dead vaccine, and that sanitary measures alone are insufficient. We are therefore amply justified in employing living cultures if there is any evidence that the method is successful, and unless it can be shown to have some definitely injurious effect.

It is difficult to determine accurately the efficacy of an abortion vaccine. To perform carefully controlled experiments of long duration with cattle is a very costly matter, and it is doubtful whether any worker has yet been able to do it on an adequate scale. A small number of controlled experiments has been made, however, and in most instances the vaccine has appeared to be of considerable value, and certainly of very much greater value than the dead vaccines which have been similarly tested. We have been forced to rely mainly on the results reported from the field, and it must be admitted that field evidence requires careful sifting and should generally be accepted with some reserve, owing to the usual impossibility of keeping a proportion of uninoculated controls. This caution is perhaps particularly required in connection with contagious abortion, on account of the frequency with which infected animals calve normally, after aborting on only one occasion. We have also to remember the common tendency of the disease eventually to "work itself out" in self-contained herds, and the great variation that may be seen, in different outbreaks, in the rate at which the infection spreads in a herd. Giving due weight to these considerations, it appears that one is justified in attaching importance to field evidence that has been gathered from a wide area, and over a considerable period of time.

The Ministry of Agriculture has issued a live vaccine since the time of the Departmental Committee, and the annual demand for it has varied only slightly, averaging 25,000 doses. From the nature of the problem it would be impracticable to attempt to obtain detailed reports of the results of inoculations, or to compile statistics of any value. In such matters favourable results are not normally reported, after the first year or two, but definitely unfavourable results may be expected to give rise to immediate complaint. For many years we have felt that the general results must be favourable, as the same practitioners obtained the vaccine year after year, and complaints of failure have always been very few indeed. Recently the Ministry decided to impose certain additional restrictions on the issue and use of the vaccine, and we communicated with all the veterinary practitioners who have obtained vaccine from us in recent years. This resulted in the receipt of a large number of letters giving information concerning the results noted in practice, and their general tone was highly favourable to the vaccine. Only one practitioner condemned it, but he appeared to have used it only in one herd, and one may doubt whether the effects described by him should be attributed to the vaccine. The general testimony in favour of the vaccine includes some very interesting points. Uninoculated controls cannot be deliberately set aside in practice, but for various reasons animals have sometimes been missed and have served as controls, although on a very small scale. Successful inoculation for a couple of years on grossly-infected premises has been suspended for one year, with disastrous results that were again checked by vaccination. A few veterinarians have also found that after preventing abortions for a number of seasons with the use of live vaccine, they have been able to stop inoculation altogether, the infection having apparently disappeared.

Over a period of many years definite failures of the vaccine have been reported in very few instances, but in those instances the failure has been almost complete. It has not been possible to investigate most of these cases at all fully, and in many of them the persistent abortions may well have had some cause other than *Br. abortus*, but in a few instances the cause has undoubtedly been *Br. abortus*. We have not been able to show that any special type of strain was present, and we have as yet no explanation for these very occasional failures.

The available evidence appears to justify the belief that in a large proportion of cases the use of live cultures reduces the number of abortions to very small proportions, or even prevents

their occurrence entirely. It appears therefore that the method is of very real economic value, and that its use is fully justified unless in some way it causes definite injury. Three objections to the method have been put forward—that it causes sterility, that it encourages the spread of the disease, and that it increases the risk of human infections.

With respect to the sterility question it is very difficult to form a confident opinion. A great deal of sterility is encountered, and in very many instances nothing definite is known of the cause. The importance of the part played by natural *Br. abortus* infection is also very uncertain. Some practitioners have had experiences that suggested strongly that the vaccination was responsible for sterility, but others have used the vaccine extensively, and for years, without noting any sterility at all. Moreover, a good deal of sterility undoubtedly occurs in the absence of *abortus*—and of vaccination. At the present time it would seem best to assume that the vaccination does sometimes cause sterility, but there is no reason to believe that it causes more sterility than would follow the ravages of the natural disease—the converse would appear to be far more probable.

The criticism that the vaccination spreads the disease would be justified if it were carried out on farms previously free from infection. The Ministry in this country, and the authorities in all other countries, have always emphasised the fact that the vaccine should be used only in infected herds, or on infected premises. More recently the Ministry, as an additional safeguard which in most instances is doubtless unnecessary, has restricted the issue of the vaccine to veterinarians who have definitely agreed to employ it only in herds in which the presence of *Br. abortus* infection has been established by laboratory tests. At the worst we are therefore spreading the infection, in an artificial and economically favourable manner, through a herd in which it is already spreading naturally and destructively.

Objections have been based on the undoubted fact that a vaccinated animal may be infective, and if sold may carry infection to a new herd. The objection ignores the fact that there is no restriction whatever on the movement of naturally infected animals (except for a few weeks after an abortion) and that the inoculated animal, which *may* be infective, is one that was definitely liable at any time to acquire natural infection, and would then have been more likely to be infective to others.

With respect to the question of human infection, it appears in the first place that when an infected herd is vaccinated, the health of the attendants is not subjected to any additional risk that deserves our serious attention. Such risk as is run by these men must surely be greatest when they attend an aborting animal or assist at a parturition. The greatest danger of infection by direct contact must be incurred by the veterinary surgeon himself, and the risk is undoubtedly diminished by any measure which reduces the number of abortions and cases of retained placenta.

The second channel of human infection, in order of importance, is believed to be the ingestion of bacilli contained in milk. Although we may believe the risk to be comparatively very small indeed, there would nevertheless be valid ground for objecting to the use of living cultures if their employment increased the output of infected milk. There appears to be no justification whatever for the assumption that vaccination has such an effect, as long as the vaccine is employed in a proper manner by responsible people. The vaccinated animal in every case is either one that is already infected, or one that is definitely exposed and likely to contract infection at any time. Moreover, infection of the udder is not a very common result of vaccination. It may occur as a direct consequence of the inoculation, but in a large proportion of cases it does not do so. It is probably true that vaccinated animals may later develop udder infection as a result of super-added natural infection, but that is most certainly true of animals that have received dead vaccine. In some quarters there has been a tendency to exaggerate greatly the frequency with which udder infection follows vaccination, and at the same time a tendency to ignore the fact that the animal, until vaccinated, was threatened with natural infection, and most probably a much greater risk of udder-infection. There appears to be no justification whatever for asserting that vaccination with live cultures increases the number of animals with infective milk; on the contrary there is some reason to believe that the number of udder cases is considerably reduced.

A defence of the use of live vaccines for premunisation does not imply satisfaction with the existing situation. There is urgent need for intensive research in the laboratory, and for careful and patient field experiments which may prove equally fruitful. It is our duty to prosecute the search for more effective dead vaccines, and to try in every way to simplify and cheapen methods of eradication and sanitary control, and to adapt them to the peculiar needs of commercial dairy herds. In the present and the immediate future, however, we have to do something to reduce the serious losses that follow when contagious abortion is unchecked. Where isolation and eradication are impracticable, vaccination with living cultures appears usually to afford very valuable and early relief, and there seem to be no valid objections to its use under properly regulated conditions.

Discussion

Professor J. Basil Buxton (Cambridge) President of the Experimental Pathology Section, occupied the chair at this, the concluding session devoted to the discussion of papers presented to Congress.

There was a large attendance of delegates when the Chairman called upon Dr. Minett who, with Professor G. S. Wilson, opened the discussion.

Dr. F. C. Minett, M.R.C.V.S. (London): The literature relating to the vaccination of cattle against infectious abortion is now fairly voluminous, but in spite of this it is often difficult to formulate definite conclusions on the subject. This difficulty has been referred to by Dr. Andrews and it exists for a number of reasons. In the first place, it has usually been necessary to carry out the experiments in naturally infected herds and, consequently, there have been numerous complicating factors, many of them beyond the control of the operator, such as variations in the natural resistance and variation in the immunity response of individual animals. Secondly, the number of animals in the different categories (heifers, cows) has often been small, and this is perhaps one of the reasons why no attempt has been made at substantiating conclusions statistically. Thirdly, there has been the difficulty of selecting a strain of suitable (in any case arbitrary) virulence, and the virtual impossibility of adjusting the virulence of the vaccine strain to that of the infecting strain. Fourthly, it is not always a simple matter to assess the value of the vaccine, because before vaccination no attempt has been made as a rule to distinguish clean animals from animals already infected. In the latter case more favourable results may be expected, because one is reinforcing an immunity already present, but possibly insufficient by itself to permit normal gestation. Fifthly, the means used for testing immunity has varied from natural exposure to infection to artificial exposure in more than one way, and for reasons which need not be discussed neither of these methods is entirely satisfactory as a practical test of immunity. Sixthly, in most cases the sole criterion used in drawing conclusions has been the natural or unnatural termination of pregnancy, and the observations are incomplete inasmuch as no attempt has been made to determine the existence of a carrier state. Finally, it is not always clear whether the vaccine has been used at what is usually recognised to be the appropriate time, *i.e.*, not less than eight weeks before service. There have also been numerous and unavoidable mistakes in that animals were pregnant at the time of vaccination.

For the reasons stated, therefore, as would be expected, the results obtained by different observers or by the same observer in different herds have varied widely; there are many gaps in the information and some of it cannot be analysed at all satisfactorily. In consequence, even at the present time, the subject, as Dr. Andrews says, is one of much controversy.

The main advantages claimed for the use of the living vaccine are that:—

(1) it is the most simple way of reducing the number of abortions and the sequelæ thereof (loss of calf, loss of milk, retention of fœtal membranes);

(2) as the result of (1) the amount of active infection in the herd is reduced;

(3) an indirect advantage claimed is that owing to local conditions there is frequently no better plan open to the owner.

The arguments that have been raised against the method are that:—

(1) so far as the prevention of abortion is concerned the benefits are variable, and the results are sometimes bad or only fair; in fact, it has been stated that the procedure may actually produce abortion;

(2) it is liable to render animals sterile;

(3) a proportion of the vaccinated animals become carriers and as a result may abort at a subsequent pregnancy, but in any case many such animals will excrete the organism in the milk, possibly for long periods;

(4) it interferes with the proper use of the agglutination test;

(5) in the larger herds, at any rate, it is necessary to continue vaccination periodically, as susceptible animals come to sexual maturity;

(6) vaccination of itself does nothing to eliminate infection from a herd; the procedure indeed gives a false sense of security and actually removes the incentive to eliminate the disease by blood-testing and segregation measures.

I wish to refer briefly to the evidence on some of these points:—

The evidence does appear to leave little room for doubt that, on the whole, vaccination, carried out at the appropriate time, does have the effect of preventing abortion in a substantial percentage of cases. On the other hand, it would be going much too far to say that vaccination abolishes clinical abortion altogether, and while some of the failures may have been due to causes other than Bang's bacillus it is

certain that a proportion of true failures are to be expected. When the available figures are examined, however, one of the striking features is their variability, so that final conclusions cannot rest upon one set of figures alone. Some observers have obtained indifferent or frankly bad results, and it is generally agreed that not only do individual animals vary in their response to immunisation, but that it is more difficult to immunise maiden heifers than animals which have passed the first or second pregnancy. It is not possible to quote extensive figures, but it deserves to be noted that in heifers in many instances the clinical abortion rate has been reduced slightly, if at all.

[At this point Dr. Minett mentioned figures which have been published by a number of authors who have studied the influence of treatment with the live vaccine upon the incidence of abortion, *viz*, those cited by Stockman (1914), Hadley (1921), Schroeder (1921), Smith and Little (1923), Bang (1928), Jensen (1931), Ziegler and Teichmann (1931), Zwick (1931).]

It has been said that the method is simple. That is true up to a point. For the owner and the busy practitioner the method, however, if properly applied, is not so simple as may at first appear. Unless the herd is very small, it is not possible at one or two visits to vaccinate animals at the most suitable time, and this difficulty will inevitably encourage carelessness. In some cases it will also be necessary to ascertain whether animals are pregnant and there is consequently a risk that some in early pregnancy may be injected. If such animals are left unvaccinated and have not previously been exposed to natural infection, it is possible that trouble may arise unless they are separated from the vaccinated animals. This, however, is a point which should perhaps not be overemphasised.

Most observers have experienced no significant trouble from local or general disturbance in the vaccinated animals, though there have been occasional reports of general disturbance to health and abscess formation at the site of injection.

It may be readily admitted that if clinical abortion is prevented, the amount of infective material on the premises is likely to decrease, though, of course, it does not follow that the genital tracts of vaccinated animals which carry their calf to time are necessarily free from *Br. abortus* at the time of parturition.

There appears to be no good evidence that the vaccine itself causes abortion, provided the method is properly carried out. This undesirable sequel may, however, occur should the animal happen to be pregnant at the time of vaccination and it may also occur if the interval between vaccination and service is too short. (Schumann and Lerche, 1931).

The general weight of the evidence appears to me to be rather against the view that vaccination produces a serious degree of sterility, though slight delay in conception has sometimes been noted and in some experiments carried out by Hart and Carpenter (1923) the conclusion seemed to them to be unavoidable that 9 out of 30 animals had been rendered sterile as the result of vaccination.

Even in experiments where the results have been favourable to the use of the living vaccine, it has been found that the treated animals are liable to become carriers of *Br. abortus*. It is not intended at the moment to suggest that the organisms carried were necessarily derived from the vaccine, but the observation does show that, speaking generally, the living vaccine may be powerless to prevent the localisation of natural infection. The existence of a carrier state is shown either by the animal's excreting the organism with the milk or from the genital tract at the time of parturition. For the reason just mentioned and also because every abortion is not due to *Br. abortus*, it is obviously a fallacy to build far-reaching conclusions solely upon the presence or absence of clinical abortion.

The work of Smith and Little (1923) goes to show that in a badly infected herd treatment with live vaccine prior to service may tend to reduce the proportion of animals with infected genital tracts at the time of parturition. So far as the udder is concerned, their results show that in a badly infected herd the proportion of animals carrying *Br. abortus* in the udder may already be high and that treatment with the live vaccine fails to reduce the proportion of udder carriers.

As Dr. Andrews says, it is doubtful whether work on a sufficiently extensive scale has been done to show whether vaccination commonly leads to localisation of the organism in the udders of heifers and cows. I am not, however, able to follow him in the conclusion that infection of the udder is not a very common result of vaccination. The experiments of Carpenter (1926) are sometimes quoted as showing that 38 per cent. vaccinated animals may harbour infection in the udder. In the original article, however, it is pointed out that the history of the animals as to freedom from abortus infection prior to vaccination was not known. The issue is, therefore, complicated by the possibility of superadded natural infection. The experiments of Cominotti (1931) do appear to show that vaccine strains of *Br. abortus* may localise in the udder. In this work 20 heifers, proved by the agglutination test to be free from abortus infection, were given two injections of living vaccine, the second injection being made four to six weeks prior to service. No fewer than 50 per cent. of these animals excreted *Br. abortus* in the milk as long as 15 to 24

months after vaccination, and since the organisms could be cultivated from the milk without added carbon dioxide it is to be presumed that they were derived originally from the vaccine.

It may be said that these points are not of practical interest, because vaccination will only be carried out in badly infected herds. But how is one to know whether a herd is badly infected, and what is to be the definition of the expression " badly infected " ? The only really satisfactory way of ascertaining the extent of infection is to carry out an agglutination test of all breeding animals. The alternative is to accept the owner's estimate and take the risk of vaccinating comparatively lightly infected herds, where other measures could perhaps be adopted to better effect. The chance of vaccination increasing the mass of infection in such lightly infected herds is also one which probably cannot be excluded.

From the point of view of the national economy, the most serious objection, in my opinion, to treatment by living vaccines is that the method does not eliminate infection from herds, but must often removes the incentive to attempt eradication. It has been frequently objected that under conditions prevailing in Great Britain it is hopeless with the majority of herds to attempt elimination of the disease by blood testing and hygienic measures involving segregation of reactors. This is an attitude with which I cannot agree and I am fortified in my opinion by the results which have been obtained in the United States, where the conditions are frequently *not* different from our own. Incidentally, it may be remarked that schemes of control based on blood-testing and segregation wherever possible have been adopted by the American Veterinary Medical Association as their official policy, and are now being carried out with considerable success in a number of the States.

Although, as Dr. Andrews says, it is necessary to refer to this matter in connection with vaccination, it is a subject which cannot be adequately dealt with at this meeting. I would, however, like to make it clear that the methods of control I have in mind are not necessarily those which involve isolation of reacting animals on separate premises, because it has been shown that owners with facilities much smaller than this can do a good deal under proper guidance to reduce the scourge of abortion.

Largely because I believe the method to be wrong in principle and, also, because I am optimistic regarding alternative methods of control, I feel strongly opposed to the wholesale application of living, more or less virulent, vaccines, even in infected herds. At the most I should look upon vaccination as a temporary expedient, pending the time when some form of segregation could be applied and attention could be paid to rearing of young stock under conditions in which they would not be exposed to infection. In the herds where at the first request from the owner the disease was reasonably quiescent I would prefer the immediate application of hygienic control measures, rather than embarking upon a policy of vaccination. In such a case I should be slow in coming to the conclusion that facilities did not exist or could not be improvised at low cost.

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Professor G. S. Wilson, M.D., F.R.C.P., D.P.H. (London School of Hygiene and Tropical Medicine), in his contribution to the opening of the discussion, said :—

Before proceeding to the subject of my paper, I should like to express my appreciation of the honour conferred on me by the National Veterinary Medical Association of Great Britain and Ireland in asking me to open this discussion. Dr. Andrews (1932) has already dealt with the historical aspect of the relationship between contagious abortion of cattle and undulant fever in man, and after a very impartial discussion of the evidence has suggested to you that the risk of human infection in this country is relatively small. While agreeing in a certain measure with this conclusion, I wish to bring before you certain facts which will, I hope, convince you that the disease is of sufficiently frequent occurrence to render unwise any attempts to minimise its importance.

By careful perusal of the literature and by the co-operation of several medical men who have kindly supplied me with notes of unpublished cases, I have been able to gather records of 136 cases of undulant fever in Great Britain and Ireland, excluding laboratory infections. The diagnosis has uniformly been made by the agglutination test, and has in 12 cases been

confirmed by the isolation of the causative organism from the patient's blood, urine or fæces.

Before reproducing the records in tabular form it is important to point out that they refer specifically to the cases under consideration, and are not necessarily indicative of the general distribution of the disease. The reason for this is that many of the cases have been detected as the result of routine examination of Widal sera, and since Widal sera are taken from a selected class of the population, namely, those persons suspected of suffering from enteric fever, it is clear that the proportion of sera reacting to *Br. abortus* will tend to be unduly high in that class of the population which is most subject to enteric fever. If it were the general practice to send blood sera to be tested specially against an *abortus* antigen from all persons suffering from undiagnosed pyrexia, it might well be found that the age, sex, occupational, and residential distribution of the cases of undulant fever was different from what it appears to be by our present methods.

Table I, which gives the geographical distribution, shows that about two-thirds of the cases have occurred in England, and nearly one-quarter in Scotland.

Table I.

Geographical distribution of undulant fever cases.

	Males.	*Females.*	*Total.*
England	60	29	89
Wales	4	1	5
Scotland	18	13	31
Ireland	10	1	11
Total ...	92	44	136

The age and sex distribution is summarised in Table II. It will be observed that the disease is more than twice as common in males as in females, and that the maximum incidence in males is between the ages of 20 and 50 years. This curious predilection for adult males is in accordance with observations made both on the Continent and in the United States of America.

Table II.

Age of undulant fever patients.

	Males.	*Females.*	*Total.*
0-10	2	3	5
11-20	9	2	11
21-30	14	10	24
31-40	20	5	25
41-50	27	6	33
51-60	10	10	20
61 and over ...	4	7	11
Not Known ...	6	1	7
Total ...	92	44	136

In Table III the patients have been grouped according to whether they lived in town or country. The distinction between the two has

Table III.

Place of residence of undulant fever patients.

	Males.	*Females.*	*Total.*
Town, including country towns	62	35	97
Country	23	8	31
Not known ...	7	1	8
Total ...	92	44	136

not always been easy to make, but it is clear that the majority of the cases have occurred amongst town dwellers who have had no contact with infected cattle.

Table IV shows the occupation of the patients. Most striking is the high incidence in medical men and in persons engaged in clerical and industrial work, the comparatively low incidence

Table IV.

Occupation of undulant fever patients.

Males.		*Females.*	
Occupation.	*No.*	*Occupation.*	*No.*
School	9	School	5
Farmer or farm labourer ...	15	Farmer's wife ...	3
Medical, surgical or dental ...	13	Housework ...	23
Clerical, manufacturing, trading or engineering	28	Clerical and nursing ...	5
Miscellaneous ...	16	Miscellaneous ...	6
Not known ...	11	Not known ...	2
Total	92	Total	44

in farmers, and the complete absence of cases amongst veterinarians. With regard to veterinarians, this absence is more apparent than real. There seems little doubt that the disease has occurred in several members of the profession, but unfortunately I have been unable to obtain exact records of these cases.

With regard to the type of illness, it is often stated that undulant fever due to *Br. abortus* is much less severe than that due to *Br. melitensis*. As a general expression of opinion this may possibly be true, but it is necessary to point out that several of the patients in this series suffered from the classical symptoms of Malta fever, including the typical undulating pyrexia, that a few patients were seriously ill, and that two patients died. The mean duration of the disease, excluding one unusually protracted case which would give a false idea of the average, was 10·9 weeks in males and 11·3 weeks in females. This does not include the time spent in convalescence, which was often very prolonged.

These are some of the facts relating to cases of undulant fever which have been brought to

my notice in one way or another. What the true incidence of the disease is in this country it is impossible to say. Many practitioners are unaware of its existence, and it is probably only a minority who are actively on the look-out for it. There are at least three reasons for supposing it to be considerably more common than is generally imagined. Firstly, the relatively large proportion of cases amongst medical men is explicable on the assumption, not that they are exposed to infection more frequently than other members of the community, but that any illness amongst them is likely to receive closer attention and more thorough investigation than is the rule with the average non-medical patient. If, therefore, all persons suffering from illness the exact nature of which was in doubt were examined with similar care, it is possible that this undue preponderance of medical practitioners in the case list would no longer be noticeable. Secondly, the rather rapid increase

Table V.

Yearly incidence of undulant fever cases.

	No. of cases.
1925	3
1926	2
1927	4
1928	3
1929	12
1930	34
1931	40

in the number of cases detected in successive years, depicted in Table V, indicates either that the disease is becoming more prevalent, or that knowledge of the disease and of its diagnosis is diffusing amongst the medical profession. Thirdly, a proportion, which may be taken as 3·5 per cent. (see Table VI), of all sera from patients with undiagnosed pyrexia are found to agglutinate *Br. abortus* in a dilution of 1/80

Table VI.

Number of sera from patients with undiagnosed pyrexia agglutinating *Br. abortus* to 1/80 or higher.

Observer.	Place of Observation.	No. of sera examined.	No. positive.
Harrison & Wilson (1928)	Manchester	42	5
Smith, F. B. (1932) ...	Preston	45	4
Messer (1932)	Newcastle-on-Tyne	186	12
Morgan (1932)	Cardiff	143	4
Cruickshank & Barbour (1931)	Glasgow	50	0
*Beattie (1932)	Edinburgh	103	9
Smith, J. (1932A) ...	Aberdeen	373	11
O'Callaghan (1932) ...	Dublin	416	2
Total		1,358	47
Proportion positive		3·5%	

* Includes some unpublished figures.

or higher—a titre which in the presence of pyrexia may usually be considered sufficient for diagnostic purposes. Unfortunately, no records of the total number of Widal sera examined are available, but we may safely take the annual figure at several thousands. If 3·5 per cent. of the patients from whom these sera are derived are suffering from undulant fever, it is probable that the annual number of cases of undulant fever must run into hundreds. To obtain a more exact indication of this number, a different form of calculation may be used. Of 399 Widal sera examined by the same workers as are mentioned in Table VI, and about which records are available, 21 per cent. agglutinated typhoid or paratyphoid bacilli in a significant titre. That is, the proportion of these sera having agglutinins to the enteric group was six times that having agglutinins to the *Brucella* group. The Registrar-General's statistics for 1930 show that 2,899 cases of enteric fever were notified in England and Wales; if we take a sixth of this number we may conclude that approximately 480 cases of undulant fever occurred in the same year. Comparison of the British and the German figures affords another method of arriving at an estimate of the prevalence of undulant fever in this country. Examination of the results published by Bach (1932) for North-West Germany, Holl (1930) for the district around Cologne, and Süpfle and Hofmann (1932) for Saxony shows that 2·9 per cent. of Widal sera agglutinated *Br. abortus* to 1/80 or over. According to Zeller (1931), who has collected figures from the various serological institutes, there were in Germany during the year October 1st, 1929, to September 30th, 1930, 626 cases of undulant fever revealed by serological examination. This figure is incomplete, because not all institutes furnished him with their results. If in Germany, with a population of 62 millions, and a proportion of 2·9 per cent. of Widal sera agglutinating *Br. abortus*, there are 626 cases a year, it is not difficult to calculate that in England and Wales, with a population of 39 millions, and a proportion of 3·5 per cent. of Widal sera agglutinating *Br. abortus*, there must in the same year have been about 480 cases. Whichever way, therefore, we make our calculations, we come to the conclusion that the real incidence of undulant fever in England and Wales is probably of the order of 500 cases a year. This may be compared with the figure of 450 cases detected annually in Denmark with a population of only 3½ millions (Kristensen, 1931), and of 100 cases in Sweden with a population of six millions (Kling, 1930). The relatively large number of cases detected in Denmark may partly be attributable to the fact that the serological work for the whole country is centralised at Copenhagen, and that a larger proportion of

sera from country districts is sent for examination than in either England or Sweden. It must be realised that too much stress is not laid on the indirect method of calculation employed here. In order for accuracy to be obtained, it would be necessary to know the proportion of Widal sera agglutinating *Br. abortus* and organisms of the enteric group in all parts of the country; unfortunately figures are available for only a limited number of areas, and it may be that the average of these figures is not identical with that which would be obtained if the figures for the whole country could be collected. Nevertheless, it seems probable that the estimate arrived at on the basis of these figures affords a much better indication of the prevalence of undulant fever than that yielded by any other method.

Coming on to the method of infection, relevant information is summarised in Table VII. It will be noticed that nine cases at the most can be traced to direct contact with infected

Table VII.

Possible method of infection.

History.	*Males.*	*Females.*	*Total.*
1. Drank raw milk from herds with contagious abortion	17	8	25
2. Drank raw milk from herds about which there was no information regarding contagious abortion... ...	38	16	54
3. Drank milk seldom or in tea or coffee only...	7	8	15
4. Contact with herds having contagious abortion	5	0	5
5. Contact with herds in which there was no information regarding contagious abortion...	3	1	4
6. No information available	22	11	33
Total	92	44	136

animals, and even in these cases, since milk was often consumed on the farm, the possibility of infection by this means could not be excluded. With regard to the remainder, 79 gave a history of drinking raw milk, while a further 15 drank milk seldom or only in tea or coffee. Of the 79 patients who admitted to drinking raw milk, 25 were found to have consumed milk from herds infected with contagious abortion. The mode of infection of the 15 persons who consumed very little milk is difficult to account for. Careful inquiry in a few of these cases revealed the fact that, though they did not drink raw milk, they were very partial to cream and consumed considerable quantities of it. Considering that *abortus* bacilli may be present in cream in comparatively large numbers, the consumption of this article seems to afford a quite possible explanation for some, at any rate, of these cases. Whether other channels of infection are responsible it is difficult to say. Rinjard and Hilger (1928) in France, Fitch, Delez and Boyd (1930) in the United States, and van der Hoeden (1932) in Holland have recorded the finding of *Br. abortus* in horses with fistulous withers. The organism has likewise been observed in fowls (Emmel and Huddleson, 1929). Neither of these sources seems to be likely, however, since most of the patients lived in towns and were probably not exposed to infection in these ways. The possibility that butter or cheese might have conveyed infection must be considered. Lerche (1931) in Germany found living *abortus* bacilli in one out of four samples of country butter examined, and has brought evidence to show that these organisms may remain viable for three weeks or so in rennet cheese made from experimentally infected milk, but are rapidly destroyed during the lactic fermentation incidental to the production of hard cheeses. In this country approximately 95 per cent. of the butter is imported (Report 1932A), and since most imported butter is of necessity made from pasteurised cream, danger from this source seems improbable. With the exception of Cærphilly and cream cheeses, most cheese consumed is manufactured by a process involving lactic fermentation, and a considerable proportion of it moreover is made from milk that has been previously pasteurised. Though it is possible that country butter and soft cheeses may contain living *abortus* bacilli and be responsible for occasional cases of undulant fever, neither butter nor cheese of the types commonly consumed seem, on the evidence at present available, to be probable sources of infection. On the other hand, milk is frequently infected with *Br. abortus*. Since my original observations made with Miss Nutt at Manchester (Wilson and Nutt, 1926), Beattie (1932) has reported 34·9 per cent. of positive samples amongst mixed milks in Edinburgh, J. Smith (1932B) 28·3 per cent. in Aberdeen, Morgan (1932) 37 per cent. in Cardiff, and Priestley (1932) 22·3 per cent. in Burnley. It is difficult, therefore, to escape from the conclusion that the majority of the cases in this series were infected by milk or cream.

The argument may be advanced that, if infection really is due to milk, undulant fever should be much more common than it is. There is a certain amount of weight in this argument, but it is a type of *a priori* reasoning that frequently leads one into difficulties. We know, for example, that an average of 6·4 per cent. of mixed milks in this country contain living tubercle bacilli (Report 1932B), yet only a fraction of the persons who consume it develop clinical tuberculosis.

The peculiarly high incidence of undulant fever in adult males is not easy to explain on the assumption of a milk-borne infection. It seems probable that more than one factor is involved. In country districts the disease, as Kristensen (1931) has shown in Denmark, is commonest in adult males because it is these who come into most frequent contact with infected animals. There is evidence to suggest that in farm workers and in veterinarians, who are peculiarly exposed to direct contact, infection frequently occurs but often remains latent, only a small proportion developing clinical undulant fever (Thomsen, 1931; Lombardo-Pellegrino, 1932). As a result of this infection, it may be assumed that a certain amount of immunity is developed which is generally sufficient to prevent the development of clinical disease on further exposure. On the other hand, in the classes of the population who are not exposed to direct contact with cattle the only common source of infection seems to be by milk. It is not unreasonable to suppose that the frequent consumption of infected milk, provided the dose of ingested organisms is not too great, gives rise to a latent infection which is followed by some degree of immunity. This would explain why clinical undulant fever is less common amongst women and children, who consume milk fairly regularly, than amongst men, who take it less frequently. There are two points in support of this suggestion. Firstly, there is the fact that amongst the normal population agglutinins to *Br. abortus* are commoner in females than in males, indicating that females more often suffer from a latent infection than males (Harrison and Wilson, 1928); and secondly the observation, that undulant fever has frequently developed in town dwellers who have just returned from a holiday in the country, where they drank considerable quantities of raw milk, suggests that a heavy infection in a non-immune person is particularly liable to give rise to disease. It is obviously premature to put forward any definite hypothesis, but the suggestion is made that the development of undulant fever is dependent partly upon the frequency and heaviness of infection, whether by direct contact or by the alimentary tract, and partly on the degree of immunity acquired as the result of a latent infection set up by a dose of organisms insufficient to break down completely the defence mechanism of the body.

In connection with the milk-borne theory of infection it is of interest to notice that no case has so far been recorded in a person who habitually consumed milk or cream that had been adequately pasteurised. This is very strikingly emphasised by a study of the cases that have occurred in towns—namely, London, Manchester, Salford, Portsmouth and Glasgow—in which more than 70 per cent. of the milk is pasteurised. There are in my series no cases from either Salford or Portsmouth. One case was reported from Manchester, in a woman who had recently returned from a holiday in the country. Three cases occurred in Glasgow: about one of them no information was obtainable; the second lived in a suburb and drank raw milk from a small farm in the neighbourhood; the third had just returned from a holiday in the country, where raw milk had been consumed. In London there are records of seven cases; a study of these is most instructive. One case occurred in 1917, before pasteurisation was common. Three patients had returned from a holiday in the country; one of them had consumed raw goat's milk, which agglutinated *Br. melitensis* to 1/250, and two of them had drunk raw cow's milk from the local farm. The remaining three cases were apparently infected in London; of these, two drank certified and one grade A raw milk. In one case, occurring in a boy of 15, who was in the habit of drinking a quart of certified milk daily, the organism was recovered from the blood stream, and contagious abortion was present on the farm supplying the milk.

In connection with raw graded milk, it is of interest to mention that two further cases have been traced to its consumption. One patient in Wales was in the habit of drinking grade A tuberculin tested milk; investigation by the veterinarian attending the herd led to the isolation of an infected animal. Another patient, a medical man in Yorkshire, drank freely of certified milk coming from a herd that was found to be infected with contagious abortion; in this case *Br. abortus* of the CO_2-sensitive bovine type was recovered from the patient's blood in the fourteenth week of the disease.

The last argument in favour of a milk-borne infection is the bacteriological evidence. Twelve strains of *Br. abortus* have been recovered from undulant fever patients; two of these were not adequately studied; the other ten belonged definitely to the bovine type. Of these ten, eight grew on isolation only in the presence of added CO_2, while two grew ærobically. The meaning of this last observation is doubtful. It is known that most strains in cows' milk are sensitive to CO_2. It is also known that strains which are used for the preparation of living vaccines have as the result of laboratory cultivation lost their sensitivity to CO_2. The finding, therefore, of non-CO_2-sensitive strains in the blood of human beings raises the question whether perhaps these patients had been infected not with the naturally occurring type of *abortus*, but with a vaccinal strain. So far no evidence has been obtained to support this possibility, and it is mentioned here mainly in order to draw the attention of other workers who may encounter such strains to the desirability of immediately

investigating the herd supplying the infected milk and finding out whether vaccination has been practised.

Summary and Conclusions

1. Records have been collected of 136 cases of undulant fever in Great Britain and Ireland. The disease is commonest in adult males, and its severity can be gauged by the fact that the average duration of the pyrexia has been about eleven weeks.

2. On the basis of serological investigations it is calculated that probably 500 cases of undulant fever occur annually in England and Wales.

3. Most cases in this country occur in the town population, and reasons are advanced for believing that the vehicle of infection is usually milk or cream.

In conclusion, I should like to record my thanks to the following medical men who have kindly supplied me with notes on unpublished cases or answered other enquiries: Sir Weldon Dalrymple-Champneys, of the Ministry of Health; Dr. C. P. Beattie, of Edinburgh; Dr. J. Smith, of Aberdeen; Dr. R. Cruickshank, of Glasgow; Dr. W. P. O'Callaghan, of Dublin; Dr. J. S. Baxter, of Belfast; Dr. W. Parry Morgan, of Cardiff; Dr. A. I. Messer, of Newburn, Northumberland; Dr. F. B. Smith, of Preston; Dr. J. D. A. Gray, of Liverpool; Dr. S. G. Platts and Dr. P. R. Cameron, of York; Dr. C. W. Sparks, of Matlock; Dr. C. H. Medlock, of Hertford; Dr. F. B. Hobbs, of Farnham, Surrey; Dr. Wyndham Parker, of Worcester; and Dr. Matthew Burn, of Birmingham.

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Sir Weldon Dalrymple-Champneys (representative of the Ministry of Health) said that all he hoped to do in the few minutes at his disposal was to give a little information on the human side of the question supplementary to that which Professor Wilson had just given them.

First of all, he would like to congratulate Dr. Andrews and Mr. Minett on their admirable papers. The speaker knew what an enormous amount of labour was involved in the investigation of that subject. He knew it to his cost, for in his report on Undulant Fever to the Minister of Health in 1929 he gave a bibliography of 457 papers in nine different languages, all of which he had read himself.

There was a perfect flood of papers on the subject at the present time, some of which were valuable, but many of which were of doubtful value, so that one had to wade through them to find what was of importance.

With regard to the diagnosis of this disease, on several occasions a certain amount of doubt had been thrown on the diagnosis of cases of undulant fever in this country, chiefly on the ground that they were being diagnosed on a low agglutination titre alone.

He had a series now of 83 cases that had been notified to him at the Ministry. This series had been added to since, but he had worked out his figures on that series for England and Wales alone. He had carefully excluded all cases in which the diagnosis was uncertain, and it did not include cases of laboratory infection.

He was working out the figures the previous night, as he thought it might interest them to know that the agglutination titre in the first 50 cases averaged just under one in 2,000. Professor Wilson had told them that diagnosis could be based on an agglutinating titre of one in 80, so that the average of his cases was far above that figure.

Dr. Andrews, referring in his paper to infection with porcine strains said that, so far as he knew, there was no evidence of such infection, and Professor Wilson had made a similar statement. He (Sir Weldon) was surprised at this, because in one case in which the speaker had

been interested, an agglutination test carried out by Professor Wilson showed that the patient's blood serum agglutinated a porcine strain of *abortus* to one in 2,500, but a bovine strain to only one in 640, which, though not conclusive of porcine infection, was very suggestive. Another suggestive case was that of a lady who had an estate in the south of England, and on this estate was a home farm, where many pigs were kept. This lady contracted the disease, and when the pigs were examined, one of them was found to be heavily infected. These cases showed that there was at least a possibility that man might be infected from pigs in this country, and he hoped veterinary officers would be on the look-out for this, and give them more reliable information on the subject.

In regard to infection by milk, this was probably the most common mode of infection. In a paper which he had recently read to the Centenary Meeting of the British Medical Association he had given some information as to the evidence with regard to milk infection in the English cases.

He had not the time now to give the full details, but an analysis of his series of 83 cases of endemic origin occurring in England and Wales showed that in 20 cases there was at least fairly good evidence of infection by cows' milk. The evidence varied in the different cases from the drinking of raw milk, together with a history of contagious abortion on the farm from which the milk came, to isolation of the *Br. abortus* from the milk and blood serum of the cow or cows giving the milk which the patient had drunk.

In addition to these 20 cases there were many cases in his series in which, though direct evidence was lacking, milk or milk products seemed to be the only possible source of infection.

With regard to direct contact, in his series of 83 cases there were 12 cases in which there was evidence suggestive of infection by direct contact. Ten of the patients were farmers, one was a dairyman and the remaining one was a milker on a farm. It was true that the evidence was not conclusive in most of these cases, but it was strongly suggestive. Five out of the 12 drank milk, but two of them contracted the disease at a suitable interval after delivering infected cows, and all were in contact with infected cows on the farms.

Professor Wilson had given an interesting estimate of the probable number of cases occurring in this country. The speaker was glad he had done so, because that estimate expressed, in his opinion, more nearly the number of cases which actually occurred, although it was extremely difficult to form any definite conclusions on this point. He thought cases were unrecorded for two reasons.

One was that in many cases medical practitioners mistook the disease for some other ailment. In one case, a patient was operated upon for gall-stones, and in another, a man's appendix was taken out. The other day the speaker had information of a woman who had her spleen taken out; she had undulant fever, and, of course, taking her spleen out did her no good.

The other reason why cases of undulant fever were not recorded was that though recognised they were not reported to anybody. He was getting doctors in various parts of the country and medical officers of health to report any cases to him, but he often heard quite casually of cases that had never been reported to anybody. That probably accounted for a good many cases all over the country of which they heard nothing. He hoped in future he would get a much more accurate estimate of the cases recorded.

Dr. Leslie Sheather (London) said he felt he stood in a sort of special position in that matter, as he had been connected with the subject for a long period and stood, so to speak, between the veterinary surgeon and the research worker in the laboratory.

If he understood Professor Wilson aright, the majority of his cases occurred in town people, but these people in a large number of cases had been visiting farms for holidays. It was a very common habit of townspeople visiting farms to go round the cowsheds and pat the animals, and so forth, so he thought that rather detracted from the evidence that milk conveyed infection.

With regard to the lack of cases recorded in farmers and farm hands, he thought it was a possible explanation that they might have contracted a very slight and perhaps quite transitory infection, and that they were immune. So far from the human point of view—but the speaker's point of view was mainly the point of view of the veterinary surgeon.

There was one point which had not been mentioned by Dr. Andrews in his admirable paper, nor by Dr. Minett in his admirable opening, but it was really the basis of the whole thing.

What was the L. S. D. of it? Since the speaker had been in practice as a pathologist, he knew that the question as to what it was going to cost always cropped up, when the owner of a herd that had got contagious abortion consulted his veterinary surgeon. The veterinary surgeon, he was quite sure, did not start injecting vaccine in a wholesale manner. He knew of a large number of cases where the practitioner had wanted to know how things stood before he gave his advice. (Applause.)

With regard to isolation and testing, he was sure in some cases the interval between testing was too long. It was his own experience, and it was what he always advised, that the non-

reacting animals should be tested at intervals of not more than two months. In one case he could call to mind, after three tests at intervals of two months, they had not had another reactor; but in another case where arrangements were made for a test to be made every two months, these arrangements were not carried out, and four months elapsed, and they had a case again.

The speaker did not want to tread on dangerous ground, but if it could be possible to reduce the cost of blood testing, he was perfectly certain they would have far more herds brought under control, and they would eradicate a large number of cases of disease. (Applause.)

He would hate anybody there to accuse him of trying to advertise himself—that was the last thing he would want to do—but he would like to tell those who were in the field what he was doing. In cases where testing was carried out simply for the purpose of ascertaining the extent of the trouble, the charge fixed was 2s. 6d. a test, but in order to prevail upon the farmers to carry on systematic testing and eliminate disease with the veterinarian's help, he had reduced the charge to one shilling for such systematic tests, and he thought that did bring it into practical politics. (Applause.)

Mr. L. E. W. Bevan (Southern Rhodesia) asked if he, as a member of the Southern Rhodesia Veterinary Association, might be permitted to say a few words on that subject, which interested him greatly, and which he thought was of the greatest importance, not only to the cattle industry of this country, but also of the various Colonies throughout the British Empire. It was probably one of the worst cattle diseases they had to face.

He would like first to refer to the infectivity of bovine abortion in man. He thought as he was the first to "start this hare," he might explain that there seemed to be a very great difference between the disease as it occurred in man in Southern Rhodesia and as it occurred in human beings in Great Britain.

In Southern Rhodesia, where there were only some 50,000 white people in all, they had had over 200, and nearly 300, diagnosed cases; whereas they had heard from Professor Wilson how very rare the disease was in this country. There seemed to be some very profound difference. Also in Southern Rhodesia there was very little doubt as to whether a person was suffering from the disease, which was a very distressing one. Here in this country he thought the medical profession appeared to have great difficulty in recognising it. He would like to ask Professor Wilson whether he had had time to get information from his laboratory work to show whether there was any difference between the *abortus* of Southern Rhodesia and that of other countries. The speaker was inclined to think there was a difference, not only from the clinical investigation of the disease, but from his own experiences, for he had found there was no difficulty in establishing a primary culture without regard to the CO_2 content of the medium, whereas in this country the contrary was the case.

It had been suggested in the course of that debate that the dwellers in towns were more frequently infected than those in the country, and it occurred to him that possibly the inhabitants of this country were so accustomed to drinking infected milk that they might acquire some slight degree of immunity to the disease. On the previous day, one of the members of the profession suggested that all milk should be labelled: "Poisonous unless Boiled." (Laughter.)

With regard to the use of live vaccine, he was sure that in certain circumstances it was the best thing to apply. Under the conditions which pertained in Southern Rhodesia, it might be applied to small herds, but in ranching conditions it would be too dangerous to apply for many reasons, which Dr. Minett had explained. It would be rarely possible to determine which cattle in large herds were pregnant and which were not. Therefore, as Director of Veterinary Research there, he had refused to issue that vaccine because he knew that if any harm resulted, the owners would seek vengeance, and the Veterinary Research Department would become seriously compromised. Therefore, he felt he must do something to help, and he prepared a vaccine which he called devitalised vaccine, which merely consisted of pathogenic organisms subjected to the influence of chloroform, and so devitalised. He explained the reasons for this procedure.

That was the best that one could do, and he thought he might claim that the results had been fairly satisfactory. It was possible that a passive immunity was derived from the application of this vaccine, and that during that passive immunity, the animal might become infected, so that the passive immunity might become an active one. Unfortunately, herd immunity was not established except as a result of a herd infection, and that was a costly process. He thought that by the use of the devitalised vaccine that process might be hastened and be rendered less costly.

Mr. N. S. Barron (Reading) said in the *Veterinary Record*, July 23rd, 1932, he read an abstract by Professor Sven Wall, of Sweden, but unfortunately he had been unable to read the original article. In this abstract, Professor Wall referred briefly to the variation in virulence of *Brucella abortus*. He did mention that when a medium was inoculated with a mixed inoculum, those strains which were of low virulence tended to outgrow those that were

more virulent. Anyone who was preparing a vaccine should consider this. It would seem that in the end, the vaccine became either non-virulent or of very low virulence. He would like to ask the author of that paper whether he considered this point really as important as the author of the paper in Sweden considered it to be.

Mr. F. H. Manley (Cyprus) stated that Dr. Andrews had said that slaughter of reactors was both unnecessary and impracticable. That was doubtless true in practically all instances, but occasions might arise when the slaughter of reactors could be justified. For instance, in Cyprus, as far as they were aware, indigenous cattle were not infected with that disease. Reactors had, however, been found in one herd of imported cattle and their progeny, and an infected and a non-infected herd had been created. He thought that in those special circumstances the slaughtering of the reactors would be justified.

In Cyprus they got some abortion in sheep and goats due to *Bacillus abortus ovis*, but although in the Mediterranean, Cyprus had apparent freedom from Malta fever in indigenous goats and undulant fever in man. The medical and veterinary authorities were naturally on the look-out for those diseases.

About two-and-a-half years ago some goats which had since been in quarantine were imported from Malta. They came with a certificate of freedom from Malta fever, according to the agglutination test. After arrival in Cyprus the goats were again tested by the Medical Bacteriologist, Dr. Gosden, using Oxford Standard Antigen, and again negative results were obtained. Several cases of abortion subsequently occurred in that herd. Last year he tested the sera himself and found two reactors, and this year he found another reactor.

How, therefore, were we to make sure of importing clean stock in our endeavours to improve the indigenous breeds?

The experience mentioned previously indicated, he thought, that the titre at times might become so low as to be non-existent for practical purposes. How many times must the test be carried out before one could be absolutely sure that a negative result was the correct interpretation?

During the last few years little improvement had been made in the method of vaccination against that disease.

He was not *au fait* with all the methods that had been employed in an endeavour to obtain a safe and efficient vaccine against abortion in cattle, but he might be allowed to mention what he thought was rather an unusual type of vaccine which had been elaborated in Italy against anthrax. That vaccine was there prepared by the addition of saponin to virulent emulsion. It was claimed that on inoculation of that mixture the saponin induced a leucocytosis which created a defensive barrier preventing the diffusion of the virulent material throughout the body, but not interfering with the antigenic properties of the mixture. That sapo-vaccine had been used extensively in Italy and other parts of the Continent with marked success. It was manufactured by a commercial concern and the exact details of its preparation had not been divulged. He had, however, prepared a small amount of anthrax vaccine of that type, which apparently gave an immunity. Was it not possible that a vaccine of a similar type, that is, with localisation of the virulent material, might be of value against contagious abortion?

Mr. A. B. Orr (Harrow) raised a question in connection with the injection of living vaccine. He said the question of inoculation and also the possible effect on human infection had been dealt with already, but there was a question which arose as to the effect that would have on pedigree cattle; not because pedigree cattle were likely to be inoculated with it, but for another reason: England was regarded, he thought, as the stock market of the world, and that was borne out by the number of animals exported from this country every year.

These animals were only accepted when they were stated to have passed the tuberculin test and also the agglutination test for contagious abortion. When using vaccine in non-pedigree herds, the result was to maintain the incidence of the disease. He did not think the incidence of the disease had been reduced as a result of vaccination; more probably, it had been increased.

In the present state of the ordinary dairy herd, cattle were constantly being sent in and brought out of herds. He thought it would be impossible to get adequate control of the movements of different cattle, and therefore they could not prevent the spread of vaccinated animals. Therefore they had no guarantee that in vaccinating animals they were not tending to spread the disease, and if they spread it among dairy herds and non-pedigree animals alone, one might say that had no effect upon pedigree herds. But on the other hand, it sounded rather absurd that a country in which pedigree cattle were reared and from which they were exported should have a very heavy incidence of contagious abortion; because although that disease might only be among cattle which were not first-rate, he did not see how they could be sure that sooner or later that disease would not spread eventually to the pedigree stock.

Whatever methods might be used to control animals inoculated with the living vaccine, they

could not get away from the fact that it was bound to occur, and they were increasing the amount of abortion in this country, with a possible serious result on the value of pedigree stock.

Dr. R. F. Montgomerie (Bangor, Wales) said he had one point which he wished to direct towards Dr. Andrews, in expectation of his reply. Dr. Andrews in that paper had, he thought, moved his ground a little from what he said a little while before. He said a little while ago that the vaccination did not set up a permanent infection. That was, that by using the live vaccine, they could not infect the virgin heifer. The essayist had, he thought, in this paper moved a little from that point, but to the speaker it was a most important point.

Had the position really been that they could not infect the virgin heifer, the speaker would be perfectly prepared to put forward for discussion the suggestion that the control of contagious abortion in this country should be attempted by the wholesale vaccination of virgin heifers. That was, if it was going to be maintained that they could not infect the virgin animal. He hoped he had made that point clear. To him it was a most important one. He would now leave the question, with the suggestion that they should continue that discussion at Llandudno.

Professor G. H. Wooldridge (London) said he thought Dr. Andrews had been well vindicated by the discussion which had taken place that day, but he agreed with Dr. Minett in that important point raised by subsequent people, that wholesale vaccination with live vaccine was by no means to be entered upon lightly. He thought the nail was hit on the head when Dr. Sheather pointed out it was found to be absolutely essential to find out to what extent the herd was infected before proceeding.

The speaker's difficulty had been as to where he should draw the line. In the case of a herd that was lightly infected, undoubtedly one must not resort to the use of live vaccine; but in those cases where they had high infection, they had already got the whole farm heavily infected, and they could not do much harm in resorting to the use of live vaccine.

He thought they should make the line fairly high. If the herd infection was as high as 20 per cent., he thought they should still call it a low percentage, and not resort to live vaccine; and he was not sure that one should not raise that figure even higher.

He felt if they did resolve to use it, they had no hope of eradication of the organism, and hence the disease, at all. They were simply perpetuating it from year to year. It must be remembered that they wanted to rid the farm pastures of infection, just as much as the individual animals.

There was the question as to whether or not the use of live vaccine would cause sterility, for it had often been said that it had this result. The speaker had made extensive enquiries among vaccine users, and he had had it stated to him that the reverse was the case: that in cases where they had had heavy sterility, the use of the vaccine had been followed by fertility.

Professor Wilson had said that 600 cases of the disease amongst humans might be accepted as having occurred. Of course, estimates could be used to prove anything, but if one accepted the suggestion that 20 per cent. of the milk is infected with *Br. abortus*, then considering the enormous amount of milk that was consumed in this country and the suggested pathogenicity of this organism for man, it was remarkable that there were only 600 cases of undulant fever produced. It was obvious that more work was required in that particular direction.

He suggested that in some instances, such as in Southern Rhodesia, where the disease had been shown definitely to affect human beings, the causal organism was really a *Brucella* of human origin which may have been implanted in the cattle, and consequently one really had a human disease transmitted by way of the cow and hence the cow was not primarily responsible for inducing the infection in man.

Dr. J. T. Edwards (London) said he wished to support whole-heartedly the views put forward by Dr. Andrews upon methods of control in bovine contagious abortion. He also stressed the need for further extensive research work upon the disease to ascertain the exact value of the methods of control that were now being tried, and discover better methods, if any such were available. Recently, he had heard severe criticism directed against the system of vaccination reported upon favourably by Dr. Andrews, this criticism being based on arguments which he (the speaker) contended showed inadequate experience of field practice. He thought he was the last to have had the honour of opening a discussion on contagious abortion before their Congress, in 1921. Since that year the chief advance had been that they had got to know a good deal more about the distribution and importance of the infection in human beings, the similarity (or, perhaps, identity) of which with undulant fever had just then been disclosed. Although this discovery was of great interest from the point of view of human and comparative pathology, in two ways at least it seemed to him that it had proved a misfortune. In the first place, it had tended to divert attention from the more purely veterinary and agricultural prospect (as was evident from the time taken at that meeting in expressing information which was of concern to human pathology) and, secondly, the analogous experience derived from the recorded attempts at immunisation

and therapy in the human disease did not lend any encouragement to veterinary workers to pursue parallel investigations. He felt that veterinary practitioners would conclude, from the evidence put before them by the preceding speakers, that the real advance in devising satisfactory means of control for the cattle disease had been almost nil. Very few accounts of work done on a sufficiently large scale upon representative herds, under controlled conditions, in the field had been published, and the testimony derived from the various accounts, on the whole, left the reader undecided as to the merits of any method of control for general use. Of the two methods that now claimed attention, namely, first, complete elimination by segregation of carriers as revealed by the agglutination test frequently applied, and, secondly, active immunisation by inoculation with live cultures before gestation, the first method had found in Dr. Minett an able protagonist. He (the speaker) had had the privilege of assisting Sir John M'Fadyean over a number of years in rather exhaustive work which was aimed at elimination of the disease by this method. There was no doubt but that this could be achieved sometimes, if the conditions prevailing on the infected farm permitted rigorous segregation of the infected from the healthy portions of the herd for a period that lasted as long as the survival of any of the infected animals on the farm. But, in the ordinary conditions of herd maintenance in this country, such as those of a commercial dairyman or tenant farmer, it was not likely that the necessary prolonged testing and segregation measures could be undertaken. The position would again be much complicated if similar measures were advocated upon the same herd for other diseases, such as tuberculosis, Johne's disease, and contagious mastitis.

He failed to follow Dr. Minett when he said that he objected to vaccination by inoculation with live cultures "on principle." The principle of immunisation seemed to him (the speaker) to be essentially similar to that of the most common method of vaccination employed in the human subject, namely, that against smallpox, and of the method of inoculation by means of which it had been found that anthrax could be satisfactorily combated in animals in countries where this disease was enzootic. In both these examples, the subject was inoculated with a live virus, attenuated in virulence, to much the same degree as he believed would be found to be the case with the artificial cultures ordinarily issued from laboratories from inoculation of cattle against contagious abortion. A point of difference might be made of the fact that the live bacilli persisted longer in the inoculated subjects, which then became "carriers" of infection, and a menace, but this seemed to him to matter little when it could be hazarded that already about 40 per cent. of the cattle of the country harboured the bacilli, sometimes of high and sometimes of low pathogenicity. The objection to vaccination seemed to him, therefore, to be based, not on any definite principle, but rather on prejudice. The recorded evidence, he felt bound to confess, was not such as to dispel prejudice against the method. There were undoubtedly great difficulties in obtaining satisfactory evidence upon its efficacy from the manner in which it had hitherto been employed in European herds, at the hands of clinical veterinarians, upon privately-owned herds. The statements made in Dr. Andrews' paper were in the nature of general impressions rather than strict evidence. It would be necessary to undertake vaccination under properly controlled conditions in selected areas over a definitely long period of years before trustworthy information could be obtained. As it was (as was admitted to him by an eminent German authority two years ago) the position in regard to vaccination (with live culture) was not satisfactory, but something had to be done, and it was the best that could be done.

From 1921 to 1929, he had had opportunities of carrying out investigations upon the disease under controlled conditions, with the enthusiastic co-operation of officers of the R.A.V.C., upon Government-owned establishments in India. The work he believed to be still in progress, and some of the main results had been referred to briefly in the Muktesar reports. The general conclusions seemed to resemble those of the Swedish official investigations, undertaken previously. About 10 per cent. of the native cattle tested in certain areas were found infected (by application of the agglutination test), but were never known to abort from this infection. This contrasted with an infection rate of about 50 per cent. and an abortion rate, over a number of years, of over 20 per cent. in certain of the Military Dairies, where cattle, largely of imported blood, were kept in conditions similar to those of European dairy herds. Inoculation of cattle with cultures of the freshly isolated causal organism resulted in a fatal septicæmia. Vaccination, before the onset of gestation, of clean cattle, in the infected herd, both with a European strain and, in later experiments, with a local strain (passaged in artificial culture until it had declined in virulence) failed to protect them against abortion. On the other hand, applications were received for advice from other Military Dairies in which a few cases of abortion were reported. Inspection of the nominal rolls of the cattle at these dairies showed that there had been a small fluctuating abortion rate not exceeding about 5 per cent. in these herds for a number of years past, and although the

infection rate as disclosed by the agglutination test amounted to about 20 per cent., it was considered that intervention in these dairies was not worth while. Again, a third class of herd was revealed where, after a period of years during which the abortion rate was small or unnoticeable, the incidence rapidly rose, in a year or two, to about 10 per cent. It was in this class of herd only, where the virulence of the local infection threatened to rise from the stationary to the highly exalted status, that eventually vaccination was deemed to be worth undertaking. Incidentally, it was found that organisms representing Feusier and Meyer's various " types " of *Brucella* were isolated from different dairies, and the vaccine despatched from the laboratory consisted of surface cultures on agar slopes of the various types, washed off by the inoculators. The results of the application of this system of inoculation awaited examination; he (the speaker) understood that officers of the R.A.V.C. were satisfied that it did produce a decrease in the abortion rate.

The evidence would, then, lend support to the view that the chances of depressing the abortion rate by inoculation with living cultures of relatively low virulence depended largely upon the severity of the prevailing natural disease; where the disease was of very high virulence the inoculation had no appreciable vaccinating effect; where the disease was of low, stationary virulence, vaccination was unnecessary; where the disease was rapidly increasing in virulence in a herd it was worth trying vaccination. A phenomenon of this kind, in which an active immunity suffered breakdown on exposure of the subject to exceptionally virulent local infection, was believed to occur also, as Dr. Andrews would recall from his own experience, in the immunisation of horses against South African horse-sickness.

Dr. L. Tobback (Colonial Office, Brussels) stated that at one time, in the Belgian Congo, he had had to deal with rapidly spreading infection among herds totalling about 5,000 cattle, which were native and half-bred stock. The trouble was typical *Br. abortus* infection, and it continued to spread rapidly in spite of testing and separation of the infected.

He procured live vaccine from the late Sir Stewart Stockman, and all heifers and cows were vaccinated, the work requiring two years for its completion. From that time, there was a slow but definite improvement in the position. The loss in calves had been very great, and more than 60 per cent. of the cows had aborted. During the worst period, the number of stock had been reduced to 4,000, but it was now 5,500, and there had not been a single case of abortion since 1927. It seemed that they had completely overcome the trouble, as long as they did not introduce new infection. It appeared, therefore, that it was definitely possible to eradicate infection through the use of live vaccine. He emphasised the fact that the vaccine had not caused sterility. He believed the live vaccine to be the best remedy that we possessed at present, and until something better could be provided, he thought that in large herds it should be used without hesitation.

THE REPLY

In replying, Dr. Andrews said that he would like first of all to express his appreciation of the papers contributed by the openers of the discussion, and of the contributions of the other speakers. He regretted very much that the shortage of time had prevented many of those present from speaking, and in particular regretted that they had not had the opportunity of learning the opinions of some of those who had to deal with the disease in practice. He was most interested in the figures brought forward by Professor Wilson, and the very full and careful analysis of them, and also the supplementary figures given by Sir Weldon Dalrymple-Champneys. His own personal conclusion was that the occurrence of human infection with *Brucella abortus* was definitely established, but that the extent of the infection was a matter of considerable doubt, and there were many points in this connection which still needed elucidation. He felt that, although in connection with particular series of cases diagnosis based on serum agglutination tests might be justified, in general, the occurrence of some fairly low agglutination titre did not justify the conclusion that a man was suffering, or had ever suffered, from actual illness caused by *Br. abortus*.

He had certainly omitted to mention in his paper that his remarks on the control of contagious abortion were intended to apply only to this country. He fully realised that conditions in other countries might call for very different measures. The actual extent of the infection in a country was obviously a point of fundamental importance. He thought that in some countries vaccination with living cultures should no doubt be prohibited, and he agreed with Mr. Roe that under certain circumstances, the slaughter of infected animals might be a very wise measure.

Dr. Minett and he (Dr. Andrews) really agreed on most of the facts, and differed only relatively slightly in their interpretation of the evidence. It was difficult to form an opinion on a number of points, because their data were in many respects incomplete, and there was no doubt of the need for intensified research, and for the careful recording of field observations in connection with the disease.

He personally felt that the balance of the evidence was in favour of using the live vaccine

under properly regulated conditions. Although it appeared sometimes to fail in its object, it appeared usually, he would say in the great majority of cases, to reduce the actual losses to insignificant proportions. He did not put it forward as an ideal method; he fully agreed with Dr. Minett in considering it a temporary method, a method that one would gladly abandon when something better and safer was available, but, at present, in a large number of cases there was no practicable and equally successful measure to take its place. He considered that vaccination with live cultures should never be employed when there was any hope of effecting total eradication, but that it was rendering valuable services in cases in which eradication was at present impracticable. He believed that, at present, there was every justification and reason for using the vaccine in suitable cases, and under properly controlled conditions. He was fortified in that opinion by noting the very similar conclusions which had been reached by such authorities as Vallée in France, and Zwick in Germany.

He believed that all of them would agree that eradication by testing and isolation was the ideal procedure. He, personally, hoped that veterinary practitioners would try to persuade stock owners to undertake eradication in every instance in which they considered that there was any real chance of carrying through the policy successfully. (Applause.)

It was usually stated that the actual proportion of a herd to show infection was the deciding factor in considering whether eradication was practicable or not. The percentage of infection was, of course, a factor of primary importance, and they should always be in possession of this particular information when they were called upon to make a recommendation. It was not, however, the only important factor. Dr. Sheather had spoken of the importance of the financial aspect. He fully agreed with all that Dr. Sheather had said with respect to keeping the cost of the testing as low as possible. Quite apart from the costs of testing, however, they had to consider the cost of any measures that they might recommend and the practicability of carrying out these measures. They should always aim at the ideal policy of eradication, but they were forced to take notice of important and often unpleasant facts in considering the practicability of eradication. One had to pay some attention to the nature and size of the farm, the nature and size of buildings, the farmer's bank balance, and such things as milk contracts.

He thought that it was probably possible for pedigree breeders in the great majority of instances to undertake eradication. It might not always be possible, but he felt that it was possible in a very large number of instances, and where it could be carried out, it should most certainly be done. Such a policy would certainly be to the owner's benefit, as well as serving the best interests of the whole country. Mr. Orr feared that the presence in ordinary dairy herds of infection set up by vaccination was a menace to pedigree herds, and drew particular attention to the fact that one could not control the movements of vaccinated animals. The speaker thought this to be a fact of very small importance, as long as the disease existed on a large scale throughout the country, more especially as it was impossible to control the movements of the very large number of naturally infected animals. Dr. Montgomerie had stated that the speaker had informed him that virgin heifers inoculated with live cultures of *Br. abortus* never became infected. He (Dr. Andrews) did not think that he had gone quite as far the that, and he thought that such an assertion was not really justified. On the evidence available, he believed that when virgin heifers were inoculated, under the conditions and with the restrictions advised in connection with the vaccination, they usually freed themselves of infection. He believed that it was, at any rate, quite exceptional for such heifers to acquire a definite or lasting infection as a result of inoculation. In the limited number of experiments carried out at Weybridge, there was no evidence that such an infection was ever acquired, but he would be slow, or he ought to be slow, to say that such a thing *never* happened. He believed it to be exceptional, but the actual strain of organism employed appeared to be of considerable importance in that connection. In any case, heifers would generally not contract a definite or lasting infection as a direct result of the inoculation, but where they were kept in an infected environment, one certainly could not guarantee that they would not later become re-infected, and possibly become definite carriers.

Mr. Barron had mentioned loss of virulence during prolonged cultivation, and its influence on the protective qualities of the strain. To test the protection conferred by a particular strain under controlled conditions, was a costly procedure which could very rarely be carried out on an adequate scale. At Weybridge, they had one strain of *Br. abortus* which had been first isolated during the investigations of the Departmental Committee. It had now been under cultivation in the laboratory for 20 years, and although it had no doubt lost much of its original virulence, it was by no means avirulent for cattle, and it was still capable of inducing abortion in a proportion of the animals inoculated with it. Some of the American work suggested that strains of low virulence conferred a lower degree of protection. It seemed

that for the purposes of vaccination, it was necessary to select strains carefully, but, at present, we had not very much definite information to guide us in the process of selection, and it was to be hoped that in the future, the process, if it had still to be employed, would be on a more definite foundation.

He believed that it was impossible to give any definite estimate of the proportion in which cows in this country were infected. We were well aware that a large number of herds were infected, but the actual proportion was difficult to estimate. When herd tests were carried out, the infection might be found in any proportion, from three or four per cent. up to something approaching 100 per cent. It was very common to find 30 or 40 per cent. of reactors.

In conclusion, Dr. Andrews stated that he had been hoping to hear something concerning the possible occurrence of infectious abortion in pigs. Information from some countries suggested that this question might have some real importance in connection with the public health aspect of the matter. The information at present available certainly did not suggest that the question was at present one of any great importance to pig breeders in this country. If any practitioner came across any outbreak of cases suggesting the occurrence of contagious abortion in pigs, the speaker appealed to him to furnish the laboratory with information and material.

. . . . .

[Dr. Minett would have wished to reply on the following lines to points raised in the discussion:—

1. *By Dr. Sheather.* The relative costs of vaccination and of control by blood testing and segregation could not be profitably discussed in open session, but the subject was one which might well be considered by the Association in committee.

Bleeding at intervals as short as two months was held to be advisable only in the very early part of an eradication scheme, but the intervals could be extended later to three and even to six months, except possibly in the case of a few animals with low titres the status of which was uncertain.

2. *By Dr. Edwards.* It could scarcely be affirmed that no real advance had taken place during the last ten years or so in field control work, in view of the progress which was being made in the United States, especially in Pennsylvania and Wisconsin. The fact that experiment field workers in the United States were in general opposed to the use of live vaccines showed that such unfavourable opinions were not necessarily based on insufficient knowledge of field practice. Unless agglutination testing of all the breeding animals in a herd was carried out at first at intervals of not more than three months and unless reasonably close contact was maintained between the laboratory and the owner or the veterinary surgeon supervising the field work, a wrong impression as to the feasibility of controlling the disease in this way might be created.

Few would deny the usefulness under certain conditions of vaccinating animals against anthrax or human beings against smallpox, but these instances were not analogous to that of contagious abortion because neither of the two diseases mentioned could be dealt with by segregation methods similar to those which had a chance of succeeding with abortion. Hence, as a matter of principle, Dr. Minett held that it was wrong in the case of abortion to advocate the use of live vaccine, which in spite of its advantages was incapable of eliminating the disease, when at the same time there was a risk of such a procedure largely supplanting a method which under certain circumstances could be made of extreme utility.

With regard to the other diseases of cattle to which Dr. Edwards had referred, *viz.*, tuberculosis, Johne's disease and contagious mastitis, it was not suggested that an individual owner should be expected to attempt elimination of all these diseases at the same time. It was still open to him, however, to do a good deal towards controlling the other diseases mentioned while concentrating upon the elimination of abortion.]

"AGRICULTURAL STATISTICS, 1931"

These returns, recently issued by the Ministry of Agriculture, contain some startling figures. For example, the area of agricultural land returned by occupiers of holdings showed a decline on the previous year of 78,000 acres; the arable area showed a reduction of 251,000 acres, which was more than double the loss recorded in the previous year; the area under tillage was 408,000 acres less, and the corn acreage was down by 307,000 acres. It is suggestive of the evident greater possibilities of milk than meat production that while the beef cattle population increased by 215,000, or 4 per cent., the number of dairy heifers in calf increased by 115,000, showing a rise of 72,500 or 20 per cent. The total output of meat, on the other hand, was 97,500 cwts. less than in 1930, and 1,103,000 cwts. below the average of the last five years, the reduction being greatest in beef, veal and mutton. The output of milk, however, was higher than in the two preceding years. Exclusive of milk fed to stock the production is estimated at 1,137,000,000 gallons as compared with 1,120,000,000 gallons in 1929-30. Egg production increased by 10 per cent., but the total value of the agricultural produce sold off farms in England and Wales was £18,830,000 less than the figure for 1929-30, the fall being mainly due to livestock and livestock produce, the value of which fell by £13,760,000. Both the sheep and pig populations were considerably up, the former by 1,433,400 and the latter by 472,800 pigs.

LATENT *BRUCELLA* INFECTIONS IN VETERINARIANS

G. S. WILSON, M.D., F.R.C.P., D.P.H.

London School of Hygiene and Tropical Medicine

The relative infrequency of clinical undulant fever in persons who are exposed to risk of infection with *Br. abortus* is explicable on one or more of the following grounds: (1) that the organism has only a low degree of virulence and is incapable of infecting human beings unless their resistance is unduly lowered. Against this is the fact that, when clinical infection does occur, it is often severe and may be fatal; (2) that only a small minority of strains are of sufficient virulence to invade the human body. This explanation, which has been favoured by a number of workers, is largely hypothetical. It is known that, after cultivation in the laboratory for a varying length of time, many strains lose their virulence for guinea-pigs, but there is to my knowledge no conclusive evidence that strains freshly isolated from bovine sources vary to any appreciable extent in their virulence to these animals. Whether they vary in their virulence to human beings can only be ascertained by direct experiment on man, and this has so far not been attempted; (3) that infection can occur only when the organism gains access to the body in sufficient dosage, either on one or more occasions. This explanation by itself does not fit the facts, for most of the recognised cases of undulant fever in this country have occurred in townspeople consuming raw milk which, as Bang and Bendixen (1931) have shown, rarely contains large numbers of *abortus* bacilli, while in veterinarians and stock farmers, exposed at times to contact with almost pure cultures of the organism, the disease has not occurred with the frequency which this explanation would demand; (4) that infection does in fact often occur, but that most infections remain latent and do not give rise to clinical disease. In favour of this explanation is the fact that latent infections are known to be quite common in cattle, constituting a great difficulty in the successful pursuit of the eradication policy of dealing with contagious abortion.

To determine the frequency of latent infections in man the simplest method is to ascertain whether antibodies to *Br. abortus* are often present in the blood serum of those persons whose circumstances render them particularly liable to contact with this organism, comparing them with control persons whose exposure is much less frequent and severe. Since the data on this subject, particularly as they concern Great Britain and Ireland, are limited, it was thought desirable to obtain further information. For this reason advantage was taken of the recent Congress of the National Veterinary Medical Association of Great Britain and Ireland at Folkestone to examine the blood serum of a number of veterinarians.

Experimental.—The lobe of the ear was stabbed with a sterile glass punch, and about 1 c.c. of blood was withdrawn into a modified Wright's capsule. After clotting, the blood was centrifuged and the serum tested for agglutinins to *Br. abortus*, bovine type, and *Br. melitensis*. Both the strains used had been isolated from human cases of infection, and both were antigenically smooth. The suspensions were prepared by washing off 2-day liver agar cultures with 0·25 per cent. formolised saline, heating to 60° C. for one hour, and standardising by opacity to match a tube containing 1,000 million per c.c. *Bact. coli*. Equal quantities of diluted serum and bacterial suspension were mixed in Dreyer's tubes, the final serum dilutions ranging from 1/20-1/2,560. Incubation was carried out in a water-bath at 55° C., the tubes being partly immersed. Readings were made after 18 hours. The end-point taken was standard agglutination, which may be defined as a uniform fine granularity throughout the tube after inversion. When necessary, the end-point was calculated from an interpolation table (Wilson and Miles, 1932).

RESULTS

The subjects were divided into two groups. Group 1 comprised 63 veterinarians coming into close contact with infected cattle, including those engaged in meat inspection. Group 2 comprised 35 veterinarians not coming into contact with infected cattle; this group was mainly composed of administrative officials, retired practitioners, and laboratory workers. Since Group 1 was considerably larger than Group 2, 30 Wassermann sera from adult males, kindly supplied me by Dr. A. B. Rosher of Charing Cross Hospital Medical School, were also examined, constituting Group 3. Groups 2 and 3 were designed to act as controls to Group 1 and to each other. The results are recorded in Tables I and II. It will be seen that in the exposed group 15 out of 63 sera reacted positively. In the 35 non-exposed veterinarians one serum reacted at 1/40; this came from a laboratory worker who was constantly handling living cultures of *Brucella* and making agglutination tests with bovine sera. In the sample of 30 Wassermann sera one specimen, sent from Southampton, reacted at 1/20. The unexposed veterinarians thus behaved as did a random sample of the adult male population, and for purposes of comparison Groups 2 and 3 may be combined. The highest titre recorded against *Br. abortus* was 1/220 and against *Br. melitensis* 1/120. The difference in the proportion of

Table I.
Actual titres of the reacting sera.

Exposed Group 1. No. tested 63. Titre to			Control Groups 2 and 3. No. tested 35 + 30. Titre to		
Serum No.	*Br. abortus.*	*Br. melitensis.*	Serum No.	*Br. abortus.*	*Br. melitensis.*
6	1/80	<1/20	47	1/40	1/40
12	<1/20	1/40	Wa 20	1/20	1/20
14	1/40	<1/20			
17	1/220	1/120			
25	1/40	1/20			
26	<1/20	1/50			
51	1/110	1/80			
55	<1/20	1/80			
56	1/80	1/80			
64	1/40	<1/20			
77	1/80	1/80			
78	1/20	1/40			
82	1/40	1/40			
90	1/20	trace 1/20			
93	1/30	1/30			

Table II.
Agglutinins in the blood serum of veterinarians.
Summarised results.

Titre.	Exposed group. Group 1. 63 veterinarians exposed to contact with infected cattle.		Control groups. Group 2. 35 veterinarians not exposed to contact with infected cattle.		Group 3. 30 male controls Wassermann sera.	
	Br.abortus.	*Br.melitensis.*	*Br.abortus.*	*Br.melitensis.*	*Br.abortus.*	*Br.melitensis.*
1/20	3	2	0	0	1	1
1/40	4	4	1	1	0	0
1/80	4	5	0	0	0	0
1/160	1	0	0	0	0	0
Total	12	11	1	1	1	1
Total agglutinating either *Br. abortus* or *Br. melitensis* at 1/20 or over	15		1		1	
Proportion positive	23·8 per cent.		3·1 per cent.			

Observed difference between the exposed and control groups = 20·7 per cent.
Standard deviation of the difference between the exposed and control groups = 6·00 per cent.
Observed difference ÷ standard deviation of difference = 3·45
Odds against this distribution being due to chance alone are about 1,800 to 1.

positive reactors in the exposed and non-exposed groups is too great to be determined by chance distribution. Since only one of the reactors gave a definite history of undulant fever, it must be concluded that the antibodies had arisen as the result of a latent infection with a member of the *Brucella* group.

In Table III the members of the exposed Group 1 have been divided, when exact information permitted, into four sub-groups, according to the length of time they had been in practice. The figures are very small and clearly insignificant, but they are in agreement with those reached by Thomsen (1931) in Denmark (see Table V). In so far as they are reliable, they suggest that latent infections are commoner in those members of the veterinary profession who have been exposed to risk of infection for a short time than in those who have been exposed for several years.

It is of interest to note that three sera in the exposed group agglutinated *Br. melitensis* but not *Br. abortus*. The explanation of this is by no means clear. Enquiry revealed that one of the subjects presenting this type of reaction was in daily contact with sheep in the slaughterhouse, and had occasional contact with goats, while another subject had little contact with sheep; about the third no information was forthcoming. One serum agglutinated both organisms, but reacted to a higher titre with *Br. melitensis* than with *Br. abortus*; this serum came from a practitioner whose work involved almost constant contact with sheep. No great

importance need be attached to this finding, but in view of the work of Dible and Pownall (1932) at Liverpool, who found *Brucella* agglutinins in the serum of cattle and sheep slaughterers but not in that of pig slaughterers, it suggests that sheep in this country may be infected to some extent with an organism of the *Brucella* group—possibly *Br. melitensis.*

The conclusions reached on the part played by infection in determining the appearance of specific antibodies are borne out by reference to the findings of other workers in different parts of the world. In Table IV are summarised the results of the examination of Wassermann sera and of the sera of healthy persons and afebrile patients for *Brucella* agglutinins. For the purpose of comparison the lowest titre selected for inclusion in this table is 1/40-1/50.

Table III.

Reactors in exposed Group 1, divided according to number of years in practice.

Years in practice.	No. exposed.	No. reacting.	Per cent. reacting.
0—5 ...	6 ...	3 ...	50
6—10 ...	15 ...	4 ...	27
11—15 ...	2 ...	0 ...	—
16 and over ...	35 ...	7 ...	20

Table IV.

Examination of normal and Wassermann sera for agglutinins to *Br. abortus* and *Br. melitensis.*

Observer.	Place.	No. of sera examined.	No. reacting.	Titre of reaction.	Highest titre observed.	Percentage of positive reactions.	Remarks.
Harrison & Wilson (1928)	Manchester ...	998 ...	18 ...	1/40 or over ...	1/1,280 ...	1·8 ...	Wassermann
Morgan (1929) ...	Cardiff ...	1,325 ...	5 ...	1/40 ...	1/40 ...	0·38 ...	„ „
Cruickshank & Barbour (1931) ...	Glasgow ...	1,522 ...	11 ...	1/40 or over ...	1/250 ...	0·72 ...	„ „
Bigger (1931)... ...	Ireland ...	500 ...	22 ...	1/50 or over ...	1/125 ...	4·4 ...	„ „
Smith (1932)... ...	Aberdeen ...	1,446 ...	30 ...	1/50 or over ...	1/400 ...	2·1 ...	„ „
Priestley (1932) ...	Burnley ...	650 ...	5 ...	1/40 or over ...	1/160 ...	0·77 ...	Probably Wassermann
Dible & Pownall (1932)	Liverpool ...	100 ...	2 ...	1/40 or over ...	1/160 ...	2·0 ...	Healthy adult males
Wilson (1932)... ...	Great Britain and Ireland	65 ...	1 ...	1/40 ...	1/40 ...	1·5 ...	35 non-contact veterinarians and 30 Wassermann
Evans (1925)... ...	U.S.A. North-East ...	500 ...	3 ...	1/40 or over ...	1/320 ...	0·6 ...	Wassermann
Arnold & Miller (1926-27)	Chicago ...	200 ...	3 ...	1/40 ...	1/40 ...	1·5 ...	„ „
McAlpine & Mickle (1928)	Connecticut ...	10,157 ...	260 ...	1/50 or over ...	? ...	2·6 ...	„ „
Carpenter, Boak & Chapman (1929) ...	Syracuse, N.Y.	4,050 ...	48 ...	1/45 or over ...	1/1,215 ...	1·18 ...	„ „
Welsh (1929)	Maryland ...	2,433 ...	40 ...	1/50 or over ...	? ...	1·6 ...	„ „
Hardy, Jordan, Borts & Hardy (1930) ...	Iowa	1,000 ...	13 ...	1/40 or over ...	1/160 ...	1·3 ...	„ „
Hardy, Jordan, Borts & Hardy (1930) ...	Chicago ...	395 ...	0 ...	1/40 ...	<1/40 ...	0·0 ...	„ „
Martin & Myers (1931)	Nebraska ...	1,000 ...	40 ...	1/40 or over ...	1/640 ...	4·0 ...	„ „
Thomsen (1931) ...	Denmark ...	69 ...	0 ...	1/50 ...	<1/50 ...	0·0 ...	Healthy persons and afebrile patients
Olin (1931)	Sweden ...	3,106 ...	193 ...	1/40 or over ...	? ...	6·1 ...	3,003 Wassermann and 102 normal

Summary.

Great Britain and Ireland	6,606 ...	94 ...	1/40 — 1/50 or over ...	— ...	1 422
U.S.A. ...	19,735 ...	407 ...	„ ...	— ...	2·062
All countries	29,516 ...	691 ...	„ ...	— ...	2·341

It is seen that in Great Britain and Ireland the average proportion of Wassermann sera and of sera from healthy persons containing *Brucella* agglutinins is 1·422 per cent., and in the U.S.A. 2·062 per cent. The low figure for Denmark and the high figure for Sweden are exceptional. The highest observed titre is included for the sake of interest, but it must not be inferred that such high titres as 1/400 or 1/1,280 are likely to be met with in the serum of healthy persons not specially exposed to infection with *Br. abortus*. Exact histories of patients are very difficult to obtain in a routine serum laboratory, but enquiry in many of the cases in which relatively high titres were recorded revealed the existence of undiagnosed undulant fever. Thus in Carpenter, Boak and Chapman's series no fewer than 26 cases of undulant fever were detected in the examination of 4,050 Wassermann sera. In some instances high titres were observed in persons who were specially exposed to infection. In Smith's series, for example, three sera reacting at 1/200 were found to come from two farm servants and a butcher. On the whole the evidence accumulated suggests that a titre of 1/100 will rarely be found in a healthy person who is not specially exposed to contact with infection or who is not drinking large quantities of raw infected milk.

The much higher incidence of agglutinins in the sera of veterinarians, slaughterers, and packing house employees is evident from Table V. Data on these classes of the population are comparatively scanty. Taking all the available figures for practising veterinarians alone, it will be noted that an average of 17·32 per cent. of sera agglutinated *Brucella* to 1/40 or higher, whereas with the inclusion of slaughterers and packing house employees the figure becomes 16·93 per cent. Contrasting this with the corresponding figure of 2·341 per cent. for Wassermann sera, there is no doubt that the difference is significant. Many high titres were encountered in the examination of the sera recorded in Table V, and a certain number of these were found to be due to an existing or past attack of undulant fever. The titres of 1/1,000 and of 1/200, for example, recorded by Thomsen, occurred in veterinarians who had recently suffered from undulant fever; while in Hardy, Hudson and Jordan's series 12 packing house employees working with hogs and having a serum titre of 1/40 or over, gave a definite history of undulant fever, while four others had suggestive histories. On the other hand it is

Table V.

Examination of sera from persons specially exposed to contact infection for agglutinins to *Br. abortus* or *Br. melitensis*.

Observer.	Place.	No. of sera examined.	No. reacting.	Titre of reaction.	Highest titre observed.	Percentage of positive reactions.	Remarks.
Dible & Pownall(1932)	Liverpool	100	12	1/40 or over	1/640	12·0	Slaughterers
Wilson (1932)	Great Britain and Ireland	63	13	1/40 or over	1/220	20·4	Veterinarians exposed to contact
Huddleson & Johnson (1930)	Michigan	49	28	1/50 or over	1/500	57·0	Practising veterinarians
Hardy, Hudson & Jordan (1929)	Iowa	217	40	1/40 or over	1/2,560	18·4	Packing-house employees
Hardy, Jordan, Borts & Hardy (1930)	Iowa	120	5	1/40 or over	1/40	4·2	Veterinarians
Knoth (1930)	Saxony	107	7	1/50 or over	1/100	6·5	Veterinarians exposed to contact
Lentze (1930)	Breslau	57	13	1/120 or over	1/1,920	23·0	Male stock farm employees
Thomsen (1931)	Denmark	18	11	1/50 or over	1/1,000	61·0	Veterinarians in practice for six months
Thomsen (1931)	Denmark	11	3	1/50 or over	1/200	27·0	Veterinarians in practice for one year
Thomsen (1931)	Denmark	65	8	1/50 or over	1/100	12·3	Veterinarians in practice for over a year
				Summary.			
	All countries	433	75	1/40 — 1/50 or over	—	17·32	Veterinarians only
	All countries	750	127	1/40 — 1/50 or over	—	16·93	Veterinarians and slaughterers, omitting Lentze's figures

clear that relatively high titres may be met with in exposed persons who appear quite healthy. In Huddleson and Johnson's series of 49 veterinarians four subjects gave a serum reaction in a titre of 1/500, yet none of them had any history suggestive of undulant fever, and in Lentze's series three persons were observed with a titre of 1/1,920, again without any history of this disease.

That antibody production may result from the ingestion of *Br. abortus* by the mouth is shown by the work of King and Caldwell (1929), who made observations on the staff and patients of a sanatorium in New York State. During November, 1926-November, 1927, when the sanatorium was supplied with raw milk from a heavily infected herd, the sera of 82 out of 599 persons tested agglutinated *Br. abortus* to 1/15 or higher; of these a few (exact numbers not stated) were found to be suffering from clinical undulant fever; these patients had titres of 1/1,200 or higher. The herd was then tested and all reactors eliminated. During November, 1927-June, 1928, when the milk supply was raw but free from abortion bacilli, the sera of 270 fresh persons were tested, and not a single one reacted.

Considering all the experimental and epidemiological data together it would appear that *Br. abortus* is an organism endowed with a moderate degree of virulence, which quite frequently infects persons who are exposed to it either by skin contact or by alimentary ingestion; that such infections generally remain latent, frequently being accompanied by antibody production but seldom causing clinical disturbance; that in a small proportion of infected persons, owing either to the receipt of an unusually heavy dosage, or to a temporary or more lasting diminution in their resistance, the organism multiplies to a sufficient extent to give rise to clinical symptoms of disease, which may vary in intensity from a fleeting indisposition to prolonged illness, prostration and death. The analogy between the behaviour of *Br. abortus* and the tubercle bacillus in the human body is so close as to require no stressing.

THE DIAGNOSIS OF UNDULANT FEVER ON THE BASIS OF AGGLUTINATION

It is not intended to discuss fully the interpretation of the agglutination reaction to *Br. abortus*; this has already been done (Wilson, 1930). The accumulation of fresh data, however, on the frequency of latent infections renders necessary a slight modification of the conclusions reached two years ago. It was then stated that "a titre of 1/100 or over, in the presence of pyrexia and other symptoms of disease, may be considered as practically diagnostic of active infection with an organism of the *Brucella* group," the assumption being that the patient's symptoms were due to the *Brucella* infection. Though this statement probably holds true in most instances, an exception should be made for sera coming from persons particularly exposed to contact with infected animals, such as veterinarians, slaughterers, and farm workers, and possibly for certain laboratory workers, and persons consuming large quantities of infected milk. If, as Huddleson and Johnson (1930) have shown, healthy veterinarians may have a titre as high as 1/500, it would clearly be unjustifiable to assume that the development of pyrexia and other symptoms of disease in such persons was necessarily due to an active *Brucella* infection. In the absence of definite clinical symptoms of undulant fever, the conclusion that the patient's illness is due to infection with *Brucella* should not be reached unless either a higher titre is recorded, or preferably the organism is isolated from the patient's blood, urine, fæces or a local discharge. This, of course, must not be taken to mean that titres of less than 1/1,000 in such patients should be disregarded, but merely that the same degree of significance cannot be attached to them as in persons not unduly exposed to infection. The final diagnosis of clinical *Brucella* infection must be made on the basis both of symptomatology and of laboratory findings.

SKIN RASHES AFTER "CLEANSING"

During the Congress special enquiry was made of those exposed to contact with infected cattle whether a skin rash developed on the arm after removing the fœtal membranes from aborting cows. Particulars were obtained of 46 veterinarians who had engaged in "cleansing" within the past two years; of these, 16 gave a history of a rash, occurring occasionally or frequently. Time did not permit of the collection of clinical details, but the following information was obtained. The rash, which is generally of an erythematous, or less often papular, type, may develop within a few minutes after the withdrawal of the arm from the vagina, or it may not come up till the following day, or as in one case for three days. Its appearance is often accompanied by sensations of itching or burning. Sometimes it fades within a few hours, but in many cases it lasts for one or more days. In one case there was a history of its lasting 6-7 days, and in another several months, though it is probable that in this last case secondary infection or other complication had occurred. The rash appears to develop only after treating infected cows. One member stated that in his case it appeared after cleansing mares but not cows. Analysis of the figures obtained showed that of 12 members in the exposed group who had antibodies in their serum five gave a history of rashes within the

past two years, while of 34 members in the exposed group, whose serum was free from antibodies in a titre of 1/20, 11 gave a history of rashes. There is no great difference in the proportions having rashes in the two groups, but the numbers are too few to justify any conclusion regarding the relation between the antibody content of the serum and cutaneous hypersensitiveness. Huddleson and Johnson (1930), who were able to investigate this question more fully, tested a number of veterinarians by means of the intradermal abortin reaction, preparing their abortin by filtration of an old broth culture of *Br. abortus*. Five veterinarians who were subject to skin rashes and whose serum contained agglutinins to *Brucella* reacted to the intradermal test; of four veterinarians who were not subject to skin rashes but whose serum contained agglutinins, three gave a positive intradermal reaction. Huddleson and Johnson state that this reaction can often be elicited in persons who have had undulant fever and in many persons who have worked with *Brucella* cultures in the laboratory, regardless of whether or not their blood serum contains specific agglutinins. The further statement is made that in those who give no history of past infection or of having been in contact with infective material the intradermal reaction is negative. They regard the rash as evidence of a specific cutaneous hypersensitiveness to the protein of *Br. abortus*, resulting from previous exposure to contact with this organism. It seems probable that this view is correct, but the subject is one which requires further investigation.

Summary and Conclusions

(1) Blood from 98 veterinarians was collected at the Folkestone Congress, 1932; of these, 63 were exposed to contact with aborting animals, while 35 had no such contact. In the first group of 63 members, the blood serum of no fewer than 15 agglutinated *Br. abortus* or *Br. melitensis* to a titre of 1/20 or over, the highest titre being 1/220. In the second group of 35 members only one positive result was obtained, a titre of 1/40 being given by the serum of a laboratory worker who was constantly handling living cultures of *Brucella* and making agglutination tests with bovine sera.

(2) These figures are compared with those of other workers, obtained by the examination of the serum both of normal persons and of persons whose occupation brings them into frequent contact with infective material, and the conclusion is reached that veterinarians, slaughterers, and farm workers frequently become infected with *Br. abortus*. In most instances the infection remains latent, but in a small proportion of cases clinical symptoms of disease or of typical undulant fever develop.

(3) The bearing of the presence of antibodies in the blood of latently infected persons is discussed in relation to the diagnosis of undulant fever.

(4) Of 46 veterinarians who had engaged in "cleansing" in the past two years, 16 gave a history of an arm rash. It seems probable that the rash is an example of cutaneous hypersensitiveness resulting from a previous or existent infection with *Br. abortus*, but further work is needed to define the specificity and the interpretation of this reaction.

In conclusion, I should like to express my indebtedness to all those who rendered this investigation possible. In addition to the members who so kindly volunteered their blood and responded to various questions by the post, I am especially grateful to Lieut.-Colonel P. J. Simpson who, as President of the Association, gave permission for the experiment to be performed, to Major T. Dalling and Dr. W. R. Wooldridge for making the necessary local arrangements, and to my two assistants, Mrs. H. M. Schwabacher and Miss C. B. Hendry, for their help in the experimental and clerical work of the investigation.

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The Veterinary Record
October 8th, 1932.

CONTAGIOUS BOVINE ABORTION

AT a time when it is sought to encourage and develop the pastoral resources of the Empire, the diseases which deplete our flocks and herds should receive the most careful consideration. It was appropriate, therefore, that Dr. Horner Andrews' masterly paper on "Vaccination against Bovine Contagious Abortion and the relation of this disease to Undulant Fever of Man" should have been presented and discussed by our members at the recent conference at Folkestone.

It was to be expected that Dr. Andrews—who has, as it were, inherited the mantle of Stockman and M'Fadyean—should have put up as good a case as possible for the "live vaccine," but he did so with such moderation and regard for the practical issues involved, that even those whose task it was to criticise his paper found it hard to find fault with his arguments. A careful perusal of his paper and the debate published in this issue, will prove instructive to our readers, but will, we fear, leave them still undecided as to the best method of dealing with this insidious and costly disease. Apparently there are three courses open to them: (1) the application of the "live" vaccine, (2) inoculation with "dead" vaccines, (3) detection and elimination by the agglutination test.

With regard to the first, Dr. Andrews tells us of its uses and abuses, and frankly admits that it has its limitations. These were fully discussed by Dr. Minett, who opened the debate, and were so numerous that they cannot be repeated here in detail but are sufficient to indicate that the "live," that is virulent, vaccine should only be applied when the disease is already estabiished in a herd and no other method of control is practicable. It is, at best, a policy of despair. In the past it has been customary to decry the so-called "dead" vaccines—vaccines composed of organisms destroyed by heat or chemical agents—but Dr. Andrews admits that "immunisation with killed organisms or extracts would, if effective, be the most desirable of methods to employ, after eradication, and it would certainly be the most practical," and that "it appears highly desirable that the possibilities in this direction should be subjected to further intensive study on an adequate scale." The success which has attended the application of vaccines made up of dead or attenuated organisms, for the prevention of other bacterial diseases justifies this opinion.

In the light of present knowledge the agglutination test appears to be our best weapon in combating contagious abortion. In several States of America the testing of herds is compulsory, but in this country the State makes little or no endeavour to control the disease, and the decision as to whether cattle are to be tested or not remains with the owner who, as often as not, prefers to suffer in silence. Even among practitioners the test is not as popular as it might be. When the results of the test are known it still remains with the latter to interpret them and make recommendations as to the measures to be adopted—a grave responsibility. In the circumstances it must be admitted that the knowledge and control of contagious abortion leaves much to be desired.

Considerable attention was devoted to the question as to whether bovine contagious abortion is infectious to man in this country. That it is so in the United States of America, Rhodesia and certain parts of Europe is beyond doubt, but in Great Britain recognised cases have been few and far between. Professor Wilson, who attended and participated in the debate, had previously tested some hundred members of the profession who voluntarily offered their blood in the cause of science. Their thickened ears and blood-stained collars bore testimony to their enthusiasm. We are told that of sixty-three of those who had previously been exposed to contact with aborting animals no less than fifteen agglutinated *Br. abortus* or *Br. melitensis*. In a second group of thirty-five who had had no such contact only one positive result was obtained.

It was to be regretted that the debate was somewhat curtailed owing to the limited time available. Many general practitioners and some visitors from overseas whose experience would have been of great interest, were prevented from speaking. It is to be hoped that the discussion will be resumed at the earliest opportunity. In the meantime, intensive research into the many problems presented by the disease should be encouraged with a view to obtaining scientific knowledge upon which to base measures of control. For contagious bovine abortion is a disease of the greatest economic importance, not only in this country but in many of the British colonies. The direct and indirect losses caused by it are so heavy that its control

(*Concluded at foot of col.* 1, *p.* 1247.)

Clinical Communication

INTUSSUSCEPTION IN BOVINES

F. T. HARVEY, F.R.C.V.S.
St. Columb

Intussusception of the bowel belongs to the domain of "urgent surgery" and is perhaps commoner in cattle than is generally supposed. For some reason, colic in bovines has been relegated to the background and regarded as a minor affair, although the correct diagnosis and successful management of such cases may tax the skill of the most experienced practitioner. Every case of colic in a bovine which does not respond in twelve hours should be suspected as one of mechanical obstruction, and in all, violent or drastic purgatives should be avoided from the first. In parturient cows one would exclude uterine torsion, and in males urinary obstruction. The so-called "gut-tie" I have never seen; it appears to be a regional condition.

Intussusception seems commonest in cattle from one to two years old, but may be met with at any age. I have known a strong cow die from an intussusception with a history of but one day's illness; purgatives however had been given. More commonly, unrelieved cases die from the fifth to the eighth day. The initial colic may be very severe, the animal appearing almost mad with pain, but this phase is usually more or less brief, the pain gradually fading after a few hours, but never entirely disappearing. It is this improvement which so often misleads—a waiting policy is begun, purgatives (more or less active) may be given, the action of which is to hasten the downward course, and in a few days death closes the scene. Two cases of intussusception recently occurred in young cattle and both were operated on; in one the bowel was irreducible and in a hopeless condition, in the other the invagination was reduced and an excellent recovery followed.

Case 1.—April 18th, 1932. Male, two years. In great pain at 6 a.m., and apparently had been so for some hours. Antispasmodics were given, the pain lessened, and one fair action of the bowels was noted. For the next three days the animal was quiet when down but when standing inclined to move backwards or extend its legs, lifting one, then another. A little blood and mucus were passed but no fæces. The owner compared the smell of the mucus to stale tripe. The lower right flank appeared somewhat prominent. The pulse rate increased and the expression became anxious. On rectal examination a painful tumour-like mass was located slightly to the left of the middle line in the lower abdomen. Arrangements were made to have the patient sent in for operation, but for one reason or another delay occurred. The abdomen was opened and the invaginated bowel brought outside, but it was almost black, and the outer layer or sheath gave way at once, so the patient was destroyed. The operation was at least two days late.

Case 2.—April 24th, 1932. *Sunday, 11 a.m.* Male, 20 months. In much pain on morning of 23rd. One pound of mag. sulph. given by owner. The right flank was slightly prominent; no peristalsis. A little blood-stained fæcal matter passed with straining. Mostly down and quiet, but when up inclined to move backwards, lifting one leg, then another. The condition one of continuous slight pain. No appetite, frequent hard pulse. A painful swelling was located by rectal examination. Situation same as in Case 1. Arrangements were made to have the animal sent for operation at once. *Operation, 7 p.m.* The right upper flank was prepared and anæsthesia induced by chloral and chloroform. On incising the peritoneum some slightly stained fluid escaped. After a careful search with the arm and hand inside almost up to the elbow, the invaginated bowel was found and brought out. Its condition was excellent, colour good, with very little engorgement. After some minutes' gentle kneading and slight traction on the neck of the intussusception the latter was seen to give a little and presently came with a run. The damage to the bowel appeared very slight and it was at once returned without any washing. More fluid escaped and the wound was closed, a little BIPP being applied to the latter. The bowels acted during the night. The patient was rather shaky for two days and required a few doses of stimulant. His subsequent progress was good, the wound healing by first intention. Sutures removed on the tenth day. Walked home, a distance of four miles, on the 16th day.

Discussion.—In cases of intussusception in cattle spontaneous reduction is no doubt possible, but it must occur early—probably during the intensive colic stage. Later, the only curative treatment is surgical and operation should be carried out without undue delay: under 48 hours, if possible. In cases of obstruction with a doubtful diagnosis an exploratory operation is advisable. If no actual cause is then found little harm results, and on three occasions I have seen definite improvement follow what appeared to have been blank operations. It is the transition from a state of intense pain to one of relative calm which is apt to mislead

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is a matter of the utmost urgency if the pastoral industries of the Empire are to be built up on a sound foundation, that is, a foundation of good health.

in intussusception of the bowel and the operation stage may thus have passed before the seriousness of the case is realised. It encourages also a waiting policy or even one of attempts at active purgation, which can only hasten the animal on its downward course. It certainly requires some courage to carry out an immediate operation in these cases and it is best, wherever possible, to have the patient sent to hospital.

Symptoms and Signs of Intestinal Obstruction.—There is nothing special in the early stage, this being usually one of colic, but with the decrease of pain the case assumes a more or less definite character. The animal, whether standing or down, if closely watched, never seems quite easy. If standing he is inclined to move backward (most important sign) or stands over more ground than usual, with tail slightly elevated and loins down (lordosis); short periods of acute pain may intervene. The right flank is perhaps somewhat prominent, but there is no hardening of the abdominal wall unless peritonitis supervenes. Peristalsis is practically absent, no fæces are passed, but a little blood and balls of mucus may be voided, the pulse rate increases daily with rise of arterial tension; appetite is lost but water may be taken. Rectal examination may induce straining and on passing the hand forward a tender spot is usually found somewhere in the abdominal cavity (in the above two cases it somewhat resembled a medium-sized orange). Later the extremities become cold, the expression pinched and anxious, the eyes sunken, the heart fails, and the patient dies.

I have never seen purgatives do anything but harm in a case of the above type. They are all hopeless, unless surgical aid can be given. Opium masks the symptoms and hastens the end.

The Operation.—It is useless attempting to reduce an intussusception unless the bowel is brought outside and sufficient of it to relieve the parts of all stretching or tension. It may appear at first sight to be a volvulus and its structure should be carefully examined. The entering layer of bowel will seem to have passed through a slit-like opening owing to the pull of the thick short mesentery, and it is this which gives the intussusception the appearance of a volvulus. It also tends to pull the apex of the tumour around towards its neck, adding to its ball-like appearance. For these reasons I do not think late recovery by sloughing of the intussusceptum (middle and returning layers) and its passage *per rectum* can ever occur in cattle as far as the small bowel is concerned. Cases have been recorded, but they all rest on surmise. Recovery in this way in man is rarely satisfactory since a fibrous stricture usually forms.

The best account of intussusception is that given by Sir F. Treves—"Intestinal Obstruction," 1884. In this book the word "appendicitis" does not occur.

. . . . .

Since the above was written an intussusception (undiagnosed) of the upper part of the jejunum has been met with in a young bullock. Duration of case six days.

Post-mortem.—The whole of the intestines, as removed by the knacker, appeared normal. The stomachs contained much material, the abomasum being greatly distended with fluid. An intussusception was discovered in the bowel removed with the stomachs. It was high up in the jejunum and was responsible for the distension of the abomasum. The intussusceptum was six inches long, easily separated from the sheath and somewhat sausage like. The obstruction was complete, but the parts gave one the impression that reduction, if attempted early, would have been easy.

Symptoms.—The symptoms differed generally from those given above, owing to the proximity of the obstruction to the pyloric opening, being more of the stomach type. A peculiar sign was the occurrence of marked splashing sounds well forward on the right side, induced by sudden pressure on the abdomen and probably due to the fluid content of the abomasum. Such sounds are, however, of no special diagnostic value since they merely indicate a hold-up of fluid material somewhere in the alimentary canal and have been noted in cases that have recovered.

It is suggested that many cattle die every year in this country from acute intestinal obstruction which might receive surgical relief.

THE NEW PHARMACOPŒIA

The General Medical Council is to be congratulated on the work of its Pharmacopœia Commission, which has resulted in the recently issued Sixth British Pharmacopœia. As this publication is designed to serve the uses of the whole of the British Empire, preparations having a local rather than a general use have been omitted and the duty of producing supplementary lists left to those authorities who may consider them to be necessary.

The standards—or their equivalents—proposed by the Permanent Commission on Biological Standardisation, appointed by the Health Committee of the League of Nations, have been accepted and the use of these standards is obligatory. The botanical nomenclature has been revised and is in accordance with the International Rules of Botanical Nomenclature.

As was to be expected, a number of preparations which were included in the Pharmacopœia of 1914 have disappeared and a number of new preparations have been included. Among the latter are diphtheria and tetanus antitoxin, insulin, liver extract, and typhoid-paratyphoid vaccine. These substances represent some of the most important conquests of disease which have been achieved during the last half century.

The new work is the subject of an informative article to be published in our next issue.

Abstracts

[Handling Tuberculin Reactors from South-eastern Iowa. Dickey, E. S. (1932). *The Bureau Veterinarian.* VIII. No. 4. p. 3.]

Dr. Dickey describes the difficulties which were encountered in Iowa when tuberculin testing of cattle in some of the south-eastern counties was first put into practice. The author makes a strong point of demonstrating to those owners who had doubts of the efficacy of the test, the lesions seen on *post-mortem* examination, and he has apparently advocated this principle in the State in which he is Inspector in Charge. The author further advises the careful handling of reactor owners, and holds the view that treatment other than considerate "would only increase the antagonism."

The method has worked well in Iowa and the author concludes with the paragraph: "If arrangements were made more often for the general public to visualise the results that inevitably follow the harbouring of tuberculosis in herds, it is believed that a more general acceptance of the test will follow this manner of accurately evaluating it." G. W. D.

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[Statistical Researches on the Incidence of Foreign Bodies in the Reticulum of Slaughter-house Cattle. Honebein, J. Inaug. Dissert. for Doctorate Hannover Veterinary College. 1931.]

Before relating the results of his own work, the author makes some interesting quotations from veterinary literature. Rust, as long ago as 1901, was struck with the number of cases of foreign body found in suspected anthrax cases. Sixty-five out of 116 cases of sudden death in cattle were definitely diagnosed as deaths due to traumatic gastritis or pericarditis. In a series of cases he also found that only 10 per cent. of them had advanced to the pericarditis stage. According to the inquiries of various workers traumatic gastritis occurs most commonly in cows over four years of age and penetration of the diaphragm is commoner in cows in late pregnancy—which is, of course, to be expected. Eber found that about 18 per cent. of 235 cases of paralysis of the rumen were attributable to the presence of foreign body. Case (U.S.A.) estimated that foreign body accounts for three-quarters of all cases of acute indigestion in cattle. Wenger, from cattle insurance returns for the canton Zürich, estimated the direct and indirect loss from ingested foreign bodies to be very large, and Kuebitz came to similar conclusions and estimated this loss to be twice as large and 10 times as large respectively as losses from foot-and-mouth disease and anthrax.

The author's research, which extends to 431 head of cattle examined after slaughter, is most conveniently covered by a table (*q.v.*).

Age. Years	Females. I	II	III	Bulls. I	II	III	Steers. I	II	III
1–1½ ...	59	1	0	23	3	1	6	1	0
2 ...	98	26	6	46	15	3	52	14	3
3 ...	44	23	9						
4 ...	22	14	5	18	10	5	37	21	6
5 and over	26	20	9						
Total	249	84	29	87	28	9	95	36	9

Column I.—Total number.

Column II.—Number containing a foreign body.

Column III.—Number showing injury by the foreign body.

In 148 of these animals (34 per cent.) sharp metallic foreign bodies were found in the reticulum; in 101 of these (23 per cent.) the foreign body lay free in the viscus and in the remainder (47 cases—11 per cent.) it lay either in the wall (22 cases—4·8 per cent.) or it had pierced the wall (25 cases—6 per cent.).

The presence of a free foreign body does not cause any structural change in the reticulum, but inflammatory changes are caused if it is fixed in the wall, whether or not it has penetrated to the serous coat.

From the statistical information collected by the author some interesting points emerge. The incidence of foreign bodies increases progressively with age, has no preferential behaviour with regard to sex, and free foreign bodies are more than twice as common as fixed ones. It would have been interesting to have statistics on the number, size, shape and sharpness of all the foreign bodies encountered, but no such information is provided. The author classifies the cases of traumatic reticulitis as follows:—reticulitis simplex (5 cases); reticulo-peritonitis fibrinosa sive fibrosa (17 cases); reticulo-peritonitis apostematosa (10 cases); reticulo-phrenitis (8 cases); reticulo-hepatitis (4 cases); and pericarditis traumatica (3 cases).

This work shows that foreign bodies are quite common and indeed are almost to be expected in old cows, and though in the majority of cases not causing obvious trouble, they may become fixed in the wall of the reticulum at any time. Operative treatment is, generally speaking, justified because, while it is left alone, a foreign body can cause a variety of serious conditions, and is only safe when out of the way altogether.

J. E.

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[Examinations into the Activity and Auscultation of the Reticulum of Cattle. Buns, A. Inaug. Dissert. for Doctorate Hannover Veterinary College. 1931.]

The author set out to discover whether auscultation of the bovine reticulum could be

usefully employed in the diagnosis of gastric disorders and he concluded that the method was of very slight assistance for that purpose. His work, however, has been done very thoroughly and it may be said that this question has been answered once and for all. The literature on the anatomy and physiology of the reticulum is quoted very fully, a good reference list is provided and the author's own work covers experiments on 50 animals.

The reticulum is best auscultated over an area situated at the lower extremities of the sixth and seventh ribs on the left side and extending to about the median line. The author prefers an instrument on the design of the Italian phonendoscope. By preliminary work on a cow having a permanent ruminal fistula the author was able to compare the sounds he heard on auscultation with the contractions of the reticulum and as a result describes a sound, which is heard as a "gluck" or "gluck, gluck" at the moment of the second or chief reticular contraction, which is followed without delay by contraction of the rumen. This applies to non-ruminating animals. In ruminating animals the regurgitation contraction precedes the normal contractions and the sound of it is heard before the chief reticular sound at the moment when the first (soundless) contraction occurs. These sounds and contractions are illustrated graphically in the original. The regurgitation sound is similar to the others and occurs at the time of the third chew following regurgitation.

J. E.

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[Laparoscopy in the Epigastric Region in Cattle. Koll, H. Inaug. Dissert. for Doctorate Hannover Veterinary College. 1931.]

The work dealt with in this and the following dissertation had for its object the improvement of diagnostic methods for abdominal diseases, particularly with regard to stomach disorders in cattle.

After practising on 55 slaughterhouse carcasses, the author employed an endoscope in 20 living animals, some of them being healthy and some patients at Professor Götze's clinic. The endoscope used consists of a 40 cm. long tube bearing an electric bulb at its extremity and a system of glass prisms, etc., for the viewing of a field with a visual angle of some 60 degrees. The best site for insertion into the abdomen was found to be in the midline half-way between the xiphoid cartilage and the umbilicus. The animals were placed in dorsal recumbency for the purpose of making the inspection.

The results of the work are set out in detail and in the majority of animals it was possible to compare the endoscope findings with ordinary *post-mortem* findings, and it was found that many disease conditions of the various parts of the stomach, diaphragm and liver could be clearly seen. The instrument was therefore judged to be quite useful as an addition to the instrumentarium of a clinic, as with its use diagnosis of (particularly) adhesions between viscera, and other conditions, can be made with some degree of certainty.

J. E.

Report

ARMY VETERINARY SERVICES

STATISTICAL AND GENERAL REPORT 1931-32

Great Britain and Northern Ireland.

The average strength of horses of the Army in Great Britain and Northern Ireland during the year was 13,327, of which 1,593 were remounts of all classes. The average strength of mules was 451. The admission for treatment were 98·52 per cent. and 31·48 per cent. respectively, and the average period sick was 18·87 days for horses and 20·82 days for mules. The average age of horses in the Army was 10·98 years and of mules 13·40 years. The average ages of horses cast for disease and cast for other causes were 12·31 years and 15·40 years respectively, while those for mules were 13·80 years and 17·32 years respectively. Wastage for veterinary reasons was 5·93 per cent.

Admissions for disease show a reduction on the previous year, excepting in the case of surgical conditions, which show a slight increase. Outbreaks of influenza occurred amongst certain units at Woolwich, Shorncliffe and London, but the disease was of a very mild type, only one case being fatal. It is important to note that 16 cases of grass sickness occurred in the Aldershot Command, 13 of which died or were destroyed. Fifteen of these cases occurred at the Remount Depôt, Arborfield Cross, and the other at Bordon.

The condition of the horses continues to show improvement, attributable to a higher standard of horsemastership in units and the policy of prophylactic treatment by veterinary services, particularly in relation to the treatment of remounts for entozoa.

Egypt.

The average strength of horses in Egypt during the year was 1,902, of which 95·42 per cent. were admitted for treatment, and the average period of time under treatment for each case was 26·19 days. Wastage for veterinary reasons was 6·88 per cent., with an average age of 13·73 years.

The average strength of mules was 817, with 56·54 per cent. of admissions for treatment, and the period of time under treatment per case was 23·84 days. The wastage of mules for

veterinary reasons was 3·79 per cent. of strength.

A clinical case of glanders in a mule occurred in the remount depôt, and one case of epizootic lymphangitis in Palestine, where the disease prevails amongst civilian animals. Two cases of tuberculosis in horses were confirmed by the tuberculin test and by *post-mortem* examination.

The condition of the animals in the Command is very good, attributable to improved animal management, better quality of forage and a greater interest taken in forage and its feeding.

Other Stations.

Three hundred and seventeen horses and 577 mules are maintained at other stations, chiefly in China (115 horses and 453 mules), Gibraltar, Malta and Ceylon.

Royal Army Veterinary School, Aldershot.

During the year six courses of instruction were held, *viz.*, one for regular officers R.A.V.C. (three months); one for Territorial officers R.A.V.C. (12 days); two in animal management, for officers of the combatant branches of the Service (four weeks each), and two in animal management for N.C.O.'s (six weeks each). Thirty-eight Territorial officers R.A.V.C. passed (eight with Distinction) and 65 combatant officers passed (17 with Distinction).

In the laboratory 1,523 examinations were made, 1,149 being fæces for helminth ova infestation, and 241 for parasitic skin disease.

The following vaccines were manufactured and issued: 1,728 doses of stock catarrh vaccine, 140 doses autogenous vaccines, 1,712 stock pustular dermatitis vaccine, and 1,760 c.cs. spleen extract. Three hundred and twenty-two doses of anti-tetanus serum and 28 doses of tuberculin were also issued. Eight thousand doses of I.D.P. mallein were manufactured and 7,070 doses were issued. Two thousand eight hundred and twenty-two doses of the subcutaneous mallein were also issued. Satisfactory reports have been received regarding the vaccine treatment of catarrh, and if the vaccine treatment is adopted in the early stages of pustular dermatitis the period of infection is reduced.

The X-ray apparatus installed at the School has been in constant use. One hundred and eighteen cases were submitted for X-ray examination, involving 250 exposures. Its value has been particularly demonstrated in navicular disease.

School of Farriery, Aldershot.

Two thousand four hundred and fifty-one horses were shod during the year, 9,270 shoes put on, and 3,495 shoes made. One hundred and ten pupils attended the School, 94·36 per cent. qualified as Farriers Group C, Class III, and the average period of instruction before such qualification was 6·2 months.

J. M.

Notes and News

The Editor will be glad to receive items of professional interest for inclusion in these columns.

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DIARY OF EVENTS

Oct. 8th.—Meeting of Scottish Society of Veterinary Inspectors, Royal Hotel, Glasgow, at 2.30 p.m.

Oct. 10th.—Meeting of the Editorial Committee, N.V.M.A., at 2, Verulam Buildings, Gray's Inn, W.C.1, at 4.30 p.m.

Oct. 13th.—Central Division, Annual General Meeting at Red Lion Square, W.C.1, at 6.30 p.m.

Oct. 13th.—Meeting of the Lincolnshire and District Division, N.V.M.A., at Lincoln.

Oct. 19th.—Meeting of the Western Counties Division, N.V.M.A., at Exeter.

Oct. 21st.—Meeting of the Mid-West and South Wales Division, N.V.M.A., at Cardiff.

Nov. 1st.—All changes of address for insertion in the 1933 Register to be reported to the Registrar, R.C.V.S.

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N.V.M.A. Clinical Prize Scheme for Students

We venture to repeat the expression of our hope that the entry for the above competition this year will show a substantial advance even upon the improved entry recorded in connection with the 1931-32 contest. Prospective entrants are reminded that their notes must be in the hands of the General Secretary, N.V.M.A., 2, Verulam Buildings, Gray's Inn, W.C.1, not later than Monday next.

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Royal Veterinary College Appeal

Government Grant Claim Sum Attained

A letter has been addressed by the Governors of the Royal Veterinary College to Mr. J. S. Elias, the manager of Odham's Press, in grateful acknowledgment of a cheque for £20,000 raised as the result of the appeal to the public made through the newspapers under their control. This sum, together with a guarantee of a further £5,000, brings the amount of the Appeal Fund to a total which enables the Royal Veterinary College to claim the Government Grant of £150,000.

At a meeting of the Finance Committee of the Corporation of the City of London the sum of £2,500 was granted towards the Rebuilding and Endowment Fund of the Royal Veterinary College.

The Fund which the *Sporting Life* initiated on behalf of the Royal Veterinary College Appeal has already reached £9,830 2s. 4d., and to this amount the proceeds of the two Meetings which the Directors of the Portsmouth and Northolt Racing Tracks held in aid of the College have still to be added. A meeting has also recently

been held on the Fund's behalf at the Manchester Greyhound Racing Track, where our colleague, Major Frank Hopkins, O.B.E., is so popular.

Captain Towler, the enthusiastic editor of the *Sporting Life*, states that he and his dog "Joey" have "put their hands to the plough" to make the amount £10,000 and that until this is attained they will "never turn back." "Joey's" collecting box alone has reached over £70, which sum will be devoted to the endowment of a kennel.

The College authorities are deeply grateful to all for their kind intentions and practical sympathy.

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R.C.V.S. OBITUARY

Kellett, Edward, Johannesburg, Transvaal, South Africa. Graduated New Edinburgh, May 30th, 1889; died September 5th, 1932.

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PERSONAL

Will.—Smith, Mr. James Francis (79), of Halesworth, Suffolk, veterinary surgeon (net personalty £6,999), £8,417.

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THE NEW MINISTER FOR AGRICULTURE

The appointment of Major Walter Elliot as Minister of Agriculture is likely to be regarded widely as an admirable selection, though there must be some regret that Sir John Gilmour will not now have the satisfaction of bringing forward those measures in the Government's long-range policy for which he has worked during the past year at the Ministry of Agriculture and at the Ottawa Conference.

The new Minister comes of farming stock, his father having been a well-known and successful farmer in the West of Scotland. Major Elliot himself is closely identified with agriculture, associated particularly with the remarkably successful work done by the Rowett Institute at Aberdeen in investigating heavy losses of stock occurring in the West Highlands of Scotland and in Kenya, which are now known to be caused by mineral deficiencies. Major Elliot may be counted on to encourage the prosecution of research on practical lines.

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BRITISH MEDICAL ASSOCIATION MEDICAL SECRETARY

Dr. G. C. Anderson, Deputy Medical Secretary of the British Medical Association since 1919, has succeeded to the post of Medical Secretary of the Association upon the retirement of Dr. Alfred Cox.

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ANOTHER FOOT-AND-MOUTH OUTBREAK IN DEVON

The Ministry of Agriculture state that the existence of foot-and-mouth disease was confirmed on Monday on premises near Combe Martin, Devon, and that the customary restriction of livestock movement order is in force.

Outbreaks of the disease in the Salcombe area of Devonshire occurred last month.

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PRESENTATION TO MR. McALLAN

"Many tributes were paid to the work of Mr. J. McAllan, M.A., B.SC., M.R.C.V.S., as veterinary officer for the city of Aberdeen during the last eleven years at a presentation made to him last night in the Caledonian Hotel by members of the Meat and Allied Trades of Aberdeen and District," says the *Aberdeen Journal* of September 22nd,

"The occasion was the forthcoming departure of Mr. McAllan as chief veterinary inspector for Northern Ireland, and the gift took the form of a silver tea and coffee service. Mrs. McAllan was also a guest, and those present at the informal dinner were the Presentation Committee, representing the subscribers of the Meat and Allied Trades.

"Mr. Robert Littlejohn, chairman of the Aberdeen and District Meat and Allied Trades, made the presentation. He had taken part in many such functions, he said, but never in one which gave him greater pleasure. Both in his official and in his private capacity Mr. McAllan had always proved himself to be a conscientious official, compelling and earning the respect and esteem of all those with whom he came in contact Mr. McAllan's official work in Aberdeen, he continued, had always given satisfaction. Ireland's gain would be Aberdeen's loss.

"In reply, Mr. McAllan spoke of the regret he felt in leaving Aberdeen and the many friends he had made in his official capacity during the last eleven years. The presentation, he concluded, would serve to remind him of many pleasant associations.

"Other members of the Committee also spoke in praise of Mr. McAllan and expressed regret at his departure."

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£48,800 FOR CLINICAL RESEARCH

The *Lancet* announces that the Rockefeller Foundation has handed to University College Hospital £48,800 "to constitute a fund for the permanent endowment of a post, the holder of which will devote his whole energies to the advancement of clinical research."

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ARMY VETERINARY SERVICE

Among the officers about to come home on leave from India is Brigadier Augustus J. Williams, D.S.O., Director of Veterinary Services, who will go on leave on November 5 and will vacate his appointment on November 28.

London Gazette—War Office—Territorial Army

Sept. 27th.—Capt. A. K. Cameron resigns his commn. and retains his rank, with permission to wear the prescribed uniform (Sept. 28).

Regular Army Reserve of Officers

Sept. 30th.—Lt.-Col. E. S. Gillett, C.I.E., having attained the age limit of liability to recall, ceases to belong to the Reserve of Officers (Sept. 15).

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WEEDS AND MILK TAINT

In an article on the "Relation of Pasture and Pasture Weeds to Flavour in Milk," in a recent issue of the *Scottish Journal of Agriculture*, Professor R. H. Leitch states:—"The following pasture weeds are reputed to cause milk taints:—Shepherd's purse, wild lettuce, golden rod, mare's tail, foxglove, horse-weed, water parsnip, fool's parsley, cowbane, yarrow, buttercups, stinking mayweed, ragwort, tansy, and bog asphodel. The evidence for implicating each or all of these weeds is not very convincing."

The Editor acknowledges the receipt of the following:—

Communications from Mr. A. J. Kennedy (Thornhill), Captain H. L. Torrance (Nottingham). Report of a meeting of the Mid-West and South Wales Division N.V.M.A., from Mr. C. E. Perry, Hon. Secretary.